AN ECONOMIC ANALYSIS OF CALAMITIES AND CONFLICTS IN RURAL CHINA: 1929-1933

A Thesis

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by

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ABSTRACT

The natural calamities and conflicts faced by Chinese farmers were overwhelming during 1929 to 1933. In this thesis I compile village level data from John Lossing Buck's nationwide survey, using techniques of regression with robust standard error and analysis of covariance to compute changes in village yields to normal or best yields as a function of agricultural area, province, time, and catastrophes. The analysis shows the geo-political governance of a province had greater impact on agricultural productivity than agricultural area did. Also time of the investigation was taken matters, which is in line with the dynamic events that arose over the 1929-1933 timeframe. Surprisingly the key impacts on agricultural productivity were natural calamities despite the wide spread warfare of the time. This is however due to a selectivity problem in that a survey team could not be sent into an area with high risk of warfare.

BIOGRAPHICAL SKETCH

Dizi Chang was born in Beijing, the capital of China, in 1989. She was chosen by Song Qing Ling Foundation as child ambassador on behalf of Chinese children to visit Fukuoka in Japan for Asian and Pacific International Conference for Children in 2000. She graduated as one of the Best Ten students from The Experimental High School Attached to Beijing Normal University and enrolled in Peking University in 2007. Having experience as monitor of 60 students for 9 years since primary school, she was advanced from candidate membership to the president of CACA, a student association in Peking University.

In 2012, she came to Cornell University to pursue her Master degree of Science in Dyson School of Applied Economics and Management. She will go to industry as a fund manager and continue her pursuit of financing and teaching career after graduation from Cornell University.

Dedicated to Professor Calum G. Turvey and Economic History Researchers.

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1.1 Problem Statement

In the period between January 1st and July 10th in 1933 the National Relief Commission in China itemized the following natural catastrophes: Chekiang with flood in 6 districts; Kiangsi with flood in 14 districts; Hunan with flood in 32 districts; Honan with flood in 11 districts, drought in 7 districts, frost in 4 districts, hailstones in 11 districts, locusts in 3 districts, and windstorm in 6 districts; Shensi with drought in 13 districts, frost in 31 districts, hail in 7 districts, wind in 37 districts, and flood in 3 districts; Kansu with earthquake in 7 districts, drought in 4 districts, famine in 30 districts, and plague in 1 district; Anhwei with wind in 2 districts, flood in 4 districts, and hail in 2 districts; Kweichow with drought in 13 districts, hail in 3 districts, flood in 4 districts, an wind in 3 districts; Kiangsu with flood in 1 district. A week after releasing this report the Yellow River, often named as “China’s Sorrow”, “The Ungovernable” and “Scourge of the Sons of Han” began to rise. In Sanyuan, Shensi province, the river rose rapidly drowning some 5,000 peasants from both farmlands and mountain area. Flooding spread to Honan, Hopeh and Shantung. By the time the Yellow River subsided, approximate 50,000 Chinese in total had perished, 2 million were rendered homeless and 1 million starving. In Changyuan district of Hopeh alone, losses were evaluated at $37,210,000 (Mexican silver), with 2,223 villages flooded, 619,000 Chinese homeless and 475,000 mu (1 acre = 6 mu) underwater.

Meanwhile China was embattled. As the Yellow River began to rise an Armistice was signed by Japan and China halting further militarism in Manchuria and areas north of the Great Wall. Between 1931 and 1932 some 222,000 Chinese, including 54,000 civilians were killed or wounded in conflicts with Japan in Manchuria and Shanghai. In Southern China Szechwan was in the midst of a senseless civil war with casualties running into tens of thousands. Communist forces under Chuh Teh and Mao Cheh-tung were in constant battle with the Nationalist forces of Chiang Kai-shek in Honan, Hunan, Fukien, Hupeh, Szechwan, Anhwei, Kiangsi and Kwangtung at a horrible toll of the agricultural economy. In Western Honan in 1932 it was reported that 50,000 people died in the strife and in Fukien the land was laid to waste and abandoned. In June of 1933 a burial detachment from the Shanghai Red Swastika (Red Cross) proceeded to Anhwei to bury 18,000 un-interred bodies.

Even in areas that were not vested in civil war or anti-communist campaigns or communist insurgency, roving warlords left over from the post republican period formed massive bandit gangs laid the havoc to rural regions. In some instances warlord armies reached tens of thousands and they joined the formal government with provincial controls.

But these were not truly governing forces and exploitation of farmers through dues or common confiscation of crops. To maintain the warlord army farmers were taxed senseless. For example Shensi province wrecked in recent years by drought and famine was one of the poorest in China. But poverty in China was not always driven by natural calamities with the remnants of the warlord period playing havoc on farm income and consumption.[1] Shensi had been under the control of the “Christian General” Feng Yu-hsiang since 1920 and it was he who ordered the paying of a land tax through 1934. The nationalist government had outlawed Likin (gift in cash) in 1930 but this was simply replaced by taxes in disguise. The central government had ordered production and consumption taxes but at the local level there were also a host of taxes and duties which farmers had to pay including land tax, poll tax, bandit-suppression duties, military dues, commissary dues, ming-tuan or militia dues, land registration fees, opium land duty, shares of provincial bank, provincial treasury note, village pacification fee, rice duty, trade tax, special tax, land deed examination fee, stamp tax and other duties and surcharges levied by local (rather than provincial) governments. Some of these taxes were extraordinarily extortionary. If the farm registration fee was not paid the land could be confiscated; the bank shares were never issued to farmers, the stamp tax was paid whether or not a shop was in the village, provincial treasury notes were apportioned and

[1] Liu, H.S.T. January 7th, 1933. The Poverty of Shensi. *China Weekly Review* vol. 63.

issued to farmers whether they wanted it or not, the lands planted to opium were decided by the province, but when yield was not sufficient the $10/mu duty had to be paid by those farmers that had not yet planted opium. And when the provincial government sent its agents to press farmers for these taxes, the agents had to be fully, and generously, accommodated and entertained at the expense of farmers. In the region of Hanchung, fertile with irrigation the net proceeded from double cropped grain, wheat and beans netted the farmer about $8/mu. The land tax on this was $3.50/mu with $12/mu required to pay for other taxes and duties, meaning the farmer had to come up with $8.50. In mountainous region of Liupan the cost of production per mu was about $3 but the levies and taxes were over $11. When these could not be paid the farmer sells or pawns whatever possessions he had (clothes, furniture etc.) and when that did not satisfy the demand, he simply moved off the land, risking torture or even death if caught.

Taxes, of course had to be paid in cash, with no facility for credit and when pressed at harvest, farmers could not afford to store grain for future sale. Hence with all farmers selling at the same time, abundance lowered the price, so that any possible benefit to store post-harvest was lost to taxes while benefits of storage were accrued to the marketers and wholesalers. And in times of scarcity, due perhaps to drought, the farmer had no crop to sell and could not afford the steep rise in prices that accompanied famine. And even if the farmer had surplus worth selling, often the commodities could not be moved. For example the local price of rice in Sian (Xi'an) was $20/picul while the local price in South Shensi was $3/picul. A merchant could profit by transporting from south to north. But the exactions and extortions along the way by 'special' tax collections, extortion by agents and city gate keepers, bandits, and lack of communication with potential buyers made the venture perilous if not unprofitable.

In the modern era strong assumptions are made in regards to agricultural productivity. The production function which captures the relationship between inputs and outputs is assumed to be well behaved and smoothly linear or non linear as the case might be. Government policies provide protection in many forms and markets are well integrated with transparent price discovery. This modern view of agricultural production and productivity rapidly breaks down in an agricultural economy in which calamities and catastrophes are more the norm than the exception, and these are not well understood.

This thesis examines the effects of catastrophes on agricultural productivity in rural China from 1929 to 1933. These were tumultuous years in Chinese history and data is scarce. However, between 1929 and 1933 Nanking University professor John Lossing Buck conducted a far reaching survey across many provinces in China. Not only was this the largest land utilization study ever conducted in China but also villages were surveyed at different points in time it provides a real-time opportunity—a natural experiment—to investigate agricultural productivity. This data, when mapped against the contemporaneous calamities or conflicts of the day provides a rare glimpse into the agricultural economics of disaster. The abbreviated list includes drought and famine, floods, civil war, banditry, the rise of communism and military action against communists, Japanese invasions and annexations of Manchuria and the Sino-Japanese war in Shanghai. In some areas of China none of these events occurred, in others all of them occurred and the natural experiment that provided by Buck's data offer the opportunity to investigate how each affected China's agricultural economy.

While the thesis is primarily an historical retrospective there are many insights that are enlightening for the present. These include a greater depth of understanding the economics of catastrophe. Nowadays agricultural productivity still fluctuates widely due to climatic variability but irrigation, genetic modification, technological adaptation all have been designed to mitigate it. As such it is difficult, for example to fully measure the social benefits of modern technologies without fully understanding the opportunity costs associated with their absence. Only a retrospective study of this sort can truly benchmark for such measures. Another area is in the valuation of land, or in the case of China Land Use Rights, and to what extent land values might respond to catastrophe induced losses in agricultural productivity. This is of particular interest to China today as it moves towards extending and providing long-term mortgages for farm land.

1.2 Objectives of the Thesis

The overall objective of this thesis is to investigate the economic consequences of calamities and conflicts on agricultural production in China from 1929 to 1933. This is supported by the following specific objectives: to explore the relation between specific events of drought, flood, conflict and agricultural productivity; to check how agricultural productivity depended on the time surveyed or on the location of provincial level; to study the impact of natural calamity and manmade conflicts on agricultural productivity; and to compare the effect of both categories of catastrophes.

Regression with robust standard error and analysis of covariance are the tailer-made modern econometric techniques for processing Buck's statistical volume to examine the effects of calamities and conflict on agricultural productivity.

Because Buck's data was gathered at different times over the five year horizon it is important to understand and interpret these data in the context of the contemporaneous environment. The contemporaneous history was gathered primarily from the China Weekly Review, an English weekly news magazine out of Shanghai that reported on events from multiple sources as they arose. As best as it was able each page of each volume was scrutinized to identify factors that in one way or another might affect agricultural productivity as reported in the survey period relative to normal productivity or the best productivity as reported by the villages surveyed. Events were categorized as major flood, major drought, bandits, civil war, communist excursions and communist eradication by Kuomingtang (KMT) nationalist forces. In addition the events of Japanese occupation in Manchuria, and incidents in Shantung and Shanghai were also considered (but ultimately abandoned from the analysis). In addition for at least two events, the central China drought of 1929 and the great flooding of 1932 were also identified as key factors. Each of these events were tabulated and converted to categorical 1-0 binaries and matched with villages in the provinces in which the events took place and that were surveyed in the same period as the event took place.

From a methods point of view the work of this thesis is original in terms of matching productivity measures gathered by survey across China with contemporaneous events. In many ways the historical developments provide a natural experiment in which to gage the various impacts examined. However the method also has its drawbacks and these ultimately appear in the results with respect to conflict. Buck's survey was not a randomized design and this has important implications, particularly with respect to conflict variables. It is highly unlikely that Buck would have sent surveyors to conflict regions of civil war, banditry, communist insurgencies or anti-insurgent battles between bandits, warlords, communists and the national forces of Chiang Kai-shek. While villages were surveyed in provinces at the time of conflict it is not known whether they were surveyed before or after a conflict, nor is it known the exact locations of the villages relative to the conflicts. Indeed, because a ‘positive’ relationship is found between agricultural productivity and conflict it can be surmised that the surveys in provinces during conflict periods were actually conducted at locations either distant in time or space from actual battles or centers of banditry. In comparison significance is found for calamities that had much wider and systemic covariant effects and can write of these with some confidence. Even so, with either conflict or banditry there were many events that are not matched with provinces or villages. For example except for a single survey in Liaoning, there are no villages in northeast China/Manchuria to capture the events of the Japanese annexation and subsequent excursions south of the Great Wall between 1931 and 1933, nor are there villages surveyed around the time of the Sino-Japanese conflict in Shanghai in 1932.

While there is always a temptation to avoid selection bias of this sort by removing event variables from the statistical analysis, there is a much broader interest in actually maintaining the variables to illustrate and document such biases in future analyses of Buck’s data so that the futility of such an analysis of conflict can be avoided. On the other hand, as is believed to be the most important contribution of this thesis, the analysis shows that any further examination of Buck’s data should be done so in the context of calamities and conflict events. On this aspect alone, the efforts contained in this thesis are well justified.

1.3 Organization of the Thesis

In sum, this thesis reexamines historical data using modern techniques. Deeply rooted in the History of China, history of land utilization is reassessed from the perspective of agricultural productivity alteration to comprehend modern economic production theory. Another attempt of the model is to identify how farmers responded to calamities and conflicts thereby adjusted their agricultural production strategy, in a view of sociological background and cultural anthropology. Chapter 2 provides an overview of China's agricultural conditions as described in Buck's Land Utilization in China, Chapter 3 provides an overview of the calamities and conflicts thought to bear influence on agricultural productivity, chapter 4 describes data and methods, chapter 5 the model development, econometric results and analysis, and the thesis concludes in chapter 6.

Finally, because of the time inherent in this thesis and the sources used, the old spelling of provincial names is kept. This is consistent with the usage in the Buck references as well as references to *China Weekly Review*. However, for consistency with the modern era Illustration 1.1 and 1.2 shows the maps for 1933 and 2014 with the provinces named accordingly. Note that the 1933 map also included Japanese annexed territory in Manchuria and Jehol. Table 1.1 lists the provincial names for 1933 and the corresponding spelling for 2014.

Illustration 1.1 Historical Name and Range for Provinces in Old China[2]

Illustration 1.2 Modern Name and Range for Provinces in New China[3]

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[2] http://www.mikalac.com/ww2/ch/pho/china1.jpg.

Table 1.1 Historical and Modern Names for Provinces Surveyed

Province in Historical Names	Province in Modern Names
Kansu	Gansu
Liaoning	Liaoning
Ningsia	Ningxia
Shansi	Shansi
Tsinghai	Qinghai
Shensi	Shaansi
Suiyuan	Inner Mongolia
Honan	Henan
Hopeh	Hebei
Anhwei	Anhui
Kiangsu	Jiangsu
Shantung	Shandong
Chekiang	Zhejiang
Hupeh	Hubei
Kiangsi	Jiangxi
Fukien	Fujian
Hunan	Hunan
Szechwan	Sichuan
Kwangsi	Guangxi
Kwangtung	Guangdong
Kweichow	Guizhou
Yunnan	Yunnan

[3] http://2.bp.blogspot.com/-UzAYWiQantg/UkVZEvocBxI/AAAAAAAAADs/ugXG82jxMdk/s211/province-english.jpg

Chapter 2: LITERATURE REVIEW AND BACKGROUND

The purpose of this chapter is to provide an overview of Buck's survey and methods, and to describe the conditions of agriculture related to agricultural productivity. This chapter deals only with the conditions as described by Buck. As noted in the introduction, Buck was to a large extent silent on the calamities and conflicts of the day and how these might have affected agricultural productivity. These calamities and conflicts are discussed in Chapter 3 and how Buck's data should be interpreted in these contexts makes up the remainder of the thesis.

2.1 Introduction: John L. Buck's Survey

The scope of Buck's study mainly contains household surveys of 2,866 farms in 17 localities and seven Chinese provinces between the year 1921 and 1924 in ***Chinese Farm Economy*** (1930); 16,786 farms in 168 localities, and 38,256 farm families in 22 provinces between the year 1929 and 1933 as published in ***Land Utilization in China*** (1937). The data used in this study are those from Land Utilization in China, but Chinese Farm Economy provides many insights into agricultural conditions of the day.

2.1.1 Chinese Farm Economy[4]

Survey method was carried on through collection of all data and it seemed the only practicable application. Tedious work had been done, in which the inclusion of a large number of farms offset the disadvantage of no written records since most Chinese farmers were illiterate but remembered each item of expense quite clearly. Errors attendant were relatively small, provided the sample was representative and the number of records was large enough to eliminate bias.

Chances of a farmer to estimate the price of an item to be too high or too low were equal and the average undoubtedly represented conditions more approximately than would information obtained from limited written records. Given that imperfections and disadvantage resides within any method, Buck found that the survey method, along the lines of emerging methods at Cornell University, proved efficient for a good understanding of farm business in China. Investigators put their main effort on part of the schedule pertaining to farm business and if possible, continued to complete the questionnaire though the length might cause difficulty. Consequently parts of the latter half were not thoroughly filled for all localities.

About one-half of the data were collected by advanced students registered for

[4] Buck, J. L. 1930. Introduction. *Chinese Farm Economy*: 1-8. Illinois, US: The University of Chicago Press.

university credit while the rest were gathered by paid assistants. Each investigator was native to the locality surveyed and was assigned on a basis of his knowledge for farm conditions. He should be acquainted with the farmers and know how to approach them, proper methods of which could only be learned by years of living and association with farmers.

Records were frequently sent in to office for checking and more times were required when some of the computations were quite complicated. Entire work of one investigator was discarded to eliminate any questionable value. The chief fear from farmers was that they would be taxed more based on information they offered, or their land confiscated by a new militarist. Such difficulties were resolved with the help of friends or relatives living in the localities studied and successfully wiping away any serious doubts in the farmer's mind.

2.1.2 Land Utilization[5]

There is an incisive connection between Buck's monograph and Cornell. Idea of a study for land utilization in China was first suggested by Dr. O. E. ***Baker***[6] from the Division of Agricultural Economics, United States Department of Agriculture at the Conference of the Institute of Pacific Relations held in Honolulu in 1926. A project was

[5] Buck, J. L. 1937. Preface. *Land Utilization in China*. Illinois, US: The University of Chicago Press.
[6] The Baker Library in Cornell University is named after Dr. Baker.

drawn up which called for the study of China's land utilization in Washington, D.C. Later, when Dr. J. B. Condliffe, Research Secretary of the Institute of Pacific Relations, visited China in the winter of 1928, he and Dr. L. T. Chen, Secretary of the China Council of the Institute, visited the University of Nanking. They were favorably impressed by the work of the Department of Agricultural Economics and asked the Department to submit a research achievement. A carefully planned study was presented. It was approved by the China Council and later by the International Research Committee of the Institute of Pacific Relations which appropriated from funds given by ***Rockefeller Foundation***[7] a series of grants for the next five years.

There was a threefold purpose: to train students in methods of research in land utilization; to make available China agriculture knowledge for its improvement, also as a basis for national agricultural policies; and to make available to people of other countries interested in certain China welfare elements about land utilization, food, and population.

Data were collected by the *sampling method* from 22 provinces. Each regional investigator was assigned a major natural region and was special trained graduate of the College of Agriculture and Forestry, University of Nanking. Intensive farm studies were implemented in 168 localities scattered in 22 provinces. Sampling was as representative of major farming types in China as possible. Sometimes the most desirable locations were

[7] The Rockefeller Hall in Cornell University is donated by the Rockefeller Foundation.

not available due to absence of suitable local investigators, or disturbed political conditions, for instance, southern Kiangsi was not under the control of Central Government at the time of investigation.

Areas studied were determined by types of farming, which were differentiated by crops using 20 percent or more of the farmer's labor, and extending over several hsiens (counties). Preliminary approximate boundaries to such areas were determined by obtaining estimates from at least three persons familiar with conditions in that and adjacent hsien. After having set the representativeness of an area, particular villages accepted were selected according to availability of a suitable local investigator and the personal contact which could be made. Personal approach for investigational work in China is absolutely important in order to ensure as accurate information as possible. There were some villages where surveys were actually started but suspicion was great that they had to be discontinued and other villages chosen instead.

For each type of farming area, a representative village (or group of small villages or hamlets) was selected, and 100 farms were studied in detail by use of the Farm Schedule. Over 250 farm families, were selected in the same village or neighboring villages for the Population Schedules. Food Surveys were procured from twenty families in most of the localities in which Farm Surveys were made. One Locality Survey schedule was filled for each community studied. One Hsien Survey schedule was acquired for each hsien where

Farm Survey occurred. These schedules were used in purpose to check accuracy of estimates obtained by sampling method with outcomes in the more detailed schedules applied for individual families or farms.

Instructions to investigators were to select farms and families in one village, or to take them consecutively along typical streets or sections for a large village. In many localities, however, this did not prove feasible, and bias might occur in data, probably resulting in the selection of samples better than average.

The country was divided into eight agricultural areas[8] and the representativeness of the studies can be observed from Table 2.1, where there is positive correlation between proportion of the studies to the cultivated area and farm population.

[8] Reference Chapter 2: 26.

Table 2.1[9] Percent of the Number of Farms Studies in the Eight Agricultural Areas to the Gross Area, the Cultivated Area, and the Farm Population

	Percentage of total for each item in each area			
	Gross area	Cultivated area	Farm Population	Farm Survey studies
CHINA	100	100	100	100
Wheat Region	33	51	41	42
Rice Region	67	49	59	58
Wheat Region Areas				
Spring Wheat	9	7	4	8
Winter Wheat-millet	11	9	6	12
Winter Wheat-kaoliang	13	35	31	22
Rice Region Areas				
Yangtze Rice-wheat	8	12	16	23
Rice-tea	18	12	16	16
Szechwan Rice	11	14	11	5
Double Cropping Rice	11	6	11	7
Southwestern Rice	19	5	5	7

The total number of hsien in which one or more types of studies were made was 308. The location of the Farm Survey studies by provinces was 154. In a few cases, information called for in the schedules had not been tabulated because it was unobtainable, unreliable or inadequate.

Shortcomings of the study were fully recognized. It had been carried out under difficulties of a limited number of trained personnel, insufficient funds for the size and comprehensiveness of the study, and amid other duties on part of the Director and members of the staff. The study was supposed to show relationships between facts rather than obtain data for current value. It was unrealistic that no errors crept into the work, but

[9] Buck, J. L. 1937. Preface. *Land Utilization in China*. Illinois, US: The University of Chicago Press.

every effort had been made to prevent them and all statistical computations had been carefully double checked.

Statistical validity of all factors studied in individual localities was believed to be reliable because at least 100 farms from each village were sampled. Whether these were random or not is not clear. Thus, statistical comparisons between areas must be made cautiously, since for several areas the number of localities studied was not great due to the limitation of funds, which has been taken into account and conclusions were drawn only where data were adequate.

2.2 China Agriculture Economy[10]

The agricultural regions and areas were much more effective as units for the understanding agriculture of the country than did the political units of provinces, the boundaries of which, in most instances, did not comprise homogeneous economic or physical conditions. This was assumed by Buck, but as will be shown later our statistical analysis brings this into question. It is found for example that the geo-political boundaries of provinces is much more significant that the agricultural regions when it comes to agricultural productivity. In fact the analysis of covariance which is undertaken shows that the combination of province and time-of-survey was far more important than the

[10] Buck, J. L. 1930. *Chinese Farm Economy*. Illinois, US: The University of Chicago Press.

agricultural regions as described by Buck. In ***Chinese Farm Economy***, Buck accepted the cursory division of China into two major regions: the North and the South, and set the boundary as the Hwai River and westward. Given the multiple typical features of North China, such as the use of carts, drilling rather than broadcasting of grain, and the abandon of liquid night soil; and the prevalence of rice growing for South China, the section between Hwai River and the Yangtze River was predominantly southern and designated as "East Central China" though it presented a gradation between North and South China conditions. (Again, when it is tested whether the broader region of north and south China were adequate descriptors of differences in agricultural productivity, no evidence is found to support the assertion.)

Illustration 2.1 Two Agricultural Regions[11]

[11] John L. Buck. 1937. *Land Utilization in China* Chapter II: 25.

Good agricultural production required optimizing every way for land usage. Besides crop growing as the principal purpose, farm land was also utilized for buildings, threshing floors, space for stacks and tethering of animals, paths, roads, ditches, dykes, boundary lines, and graves. Confining farmstead to the smallest possible area was necessary since land available for a farm family was limited. Though areas occupied by graves, boundary lines, and dykes were not a sheer loss from production perspective because the grass there could be used for pasturing animals, for fodder, or be allowed to grow until being cut for fuel. While facilities especially graves, still deprived quite amount of good land[12] for better utilization in that provided total amount of arable land, an increase in size of a farm would cause a corresponding decrease in some other farm unless the increase came from newly deposited soil by rivers or streams, or by the exploitation of arable land not formerly included.

Size of farm business was in general positively correlated with profits and capital, but it did not determine yields. Farm earnings for seventeen localities surveyed amounted to $106 for farms in the small size-group compared with $439 in the large size-group. Earnings increased significantly with each succeeding size-group of farms and merely two localities exhibited a constant or diminishing tendency on returns as exception.[13]

[12] The grave area accounted for 1.9 % of area for the whole country; and 7 % of total farm land area. Buck, J. L. 1937. *Land Utilization in China* Chapter VI: 174; Buck, J. L. 1930. *Chinese Farm Economy* Chapter II: 32.

[13] The succeeding size-groups are: small, medium small, medium, and large; The standard for size classification is: profits, labor efficiency, quality of business, as well as capital efficiency, such as receipts per mu, expenses per mu, and

Typically both capital amount and farm size would show the same extent of increase in farm labor earnings, since most of the farm capital was reinvested on land. In order to support family, small farm could not hold as much unproductive land (such as low, alkali, or sandy land) as the large farm did. Hence yields on small farms in several localities were greater than on large farms due to larger proportion of the more fertile land, however, the difference of crop yields between small and large farms was very slight, about 3%. Given relation of farm size to profits, labor efficiency, business quality, and capital efficiency, farms in the large size-groups were the most profitable. But since the most economical unit of farm was usually family sized, the optimized size of farm would vary according to family size, types of crops grown, and soil productivity.

Property right played a pronounced role on impacting labor efficiency. Given observation that profits were higher for owners, if these same owners need to pay rent or interest on the value of their property, they would receive even smaller income than the tenants because owners seldom struggled as hard as tenants did by taking advantage of obtaining income from their property. The more inherited property a farmer owned, the less need he felt to exert himself to utmost for a living even though he has little education, and ultimately the less well he would perform. Thus from the perspective of man labor as input, tenants with little inherited property would better the yield.

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interest on capital investment. Buck, J. L. 1930. *Chinese Farm Economy* Chapter IV: 107; 101.

2.3 The Productivity of Farmland[14]

Production on farmland was affected by many elements, all of which could be sorted into three types: ***Geographic Physical Prerequisite***, ***Historical Inherited Convention***[15], *and* ***Current Artificial Temporal***.

First ***geographically***, physiography[16] combined with topography shapes climate, represented by monsoon, cyclonic storms and anticyclones. For example, the unreliability of rainfall caused by particular summer monsoon[17], which brought longer growing season for most agricultural areas in China than in the United States, would either reduce crop yields to even a complete failure, or delay crop planting at the proper timing to prevent it. Evaporation was additionally eventful on determining the needed amount of water for irrigation, not only for dry land crops, but also for rice. Factors of climate included moisture[18], temperature, sunshine, wind and hail. Oftentimes as calamities[19] to farmland

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[14] Buck, J. L. 1937. *Land Utilization in China*. Illinois, US: The University of Chicago Press.

[15] "Custom is often responsible for the type of farming". Buck, J. L. 1937. *Land Utilization in China* Chapter VII: 208.

[16] Such as the "karst" topography in Double Cropping Rice Area. Buck, J. L. 1937. *Land Utilization in China* Chapter II: 82.

[17] In the case of the summer monsoon, the heat and the saturation of the atmosphere alone are not sufficient to bring rain. Air cooling by the passing of depressions is necessary, either in the violent typhoon type which bring heavy rainfall, or in a form of marine depression. If such depressions are few then rainfall becomes inadequate. Because the complication of the mechanism is general, the lack of any above factor may bring disaster. Buck, J. L. 1937. *Land Utilization in China* Chapter IV: 112.

[18] The rate of precipitation decrease becomes quite marked between the Yangtze and the Hwai River Valleys and along the Tsingling Mountain Range, which is the most important factor in determining the boundary between the Wheat and the Rice Regions as amount of precipitation in China decreases from the southeast to the northwest until the great deserts are reached. Rice Region has a mean annual precipitation of 51 inches, as compared with the Wheat Region which has less than one-half as much, 21 inches. Buck, J. L. 1937. *Land Utilization in China* Chapter IV: 108.

It is the combined effect of the monsoons and of the continental cyclones which gives the Rice Region more precipitation than the Wheat Region. Buck, J. L. 1937. *Land Utilization in China* Chapter IV: 109.

North of the "rice-line" the rainfall is both much less in amount and less dependable on the monsoons. Buck, J. L.

production, flood, drought, wind, frost, hail and even insects were triggered by climate. Among these, droughts and floods were chief causes of famines[20], which was another calamity. The former (droughts) occurred twice frequently as the latter (floods) averaged to hsien.

Soil was grouped into different classifications: calcareous alluvium, chestnut-colored earths and black earths, gray and yellow-gray desert soil, and alkali soil belonged to Calcium Soil; non-calcareous soil, purple-brown forest soil in Szechwan, slightly podzolized and neutral brown forest soil, red and yellow soil, podzolic soil, and rendzinas belonged to Leached Soil. Soil was sorted according to the extent of being leached from moderately to strongly, or from slightly to none. Appropriate coordination between sufficient supply of irrigation water and plenty of organic manures would possibly give rise to good yields even on the sterile sandy soil, while heavy fertilization without irrigation could definitely lead to a bad effect. Since addition of fertilizers onto dry land caused the soil water concentrating severely with soluble materials for the plants unable to absorb it, plants would die of "physiological drought". Irrigation could dilute

1937. *Land Utilization in China* Chapter IV: 119.

[19] Classification of calamities references to Table 9 in Chapter 1: Number of Calamities Occurring during the Period 1904-1929 and the Average Percentage of Damage Caused by Them. Buck, J. L. 1937. *Land Utilization in China*— Statistics: 13-15.

[20] Famines in China are caused chiefly by unfavorable weather conditions, mainly performed as droughts and floods. Water, too much or too little, is the greatest element affecting the precariousness of farming in China. Highest number of famines occurred in the Szechwan Rice and the Winter Wheat-millet Areas. Famines are more severe in the Wheat Region than in the Rice Region, in the Spring Wheat and Winter Wheat-millet Areas than in the Winter Wheat-kaoliang Area, and in the Szechwan Rice Area than in other areas of the Rice Region. Buck, J. L. 1937. *Land Utilization in China* Chapter IV: 125.

the fertile soil solution to some concentration that was beneficially absorbed by plant roots. Conversely, soil erosion, arose from the loss of soil fertility, choked stream channels and intensified the likelihood and severity of floods.

Second, with ***Historical Inherited Convention***, such as the success of the land use, the tenancy relationship, racial custom[21], and the prior sales channel, China was divided into two major agricultural regions— the Wheat Region and the Rice Region[22], and eight sub-regions named "areas"— the Spring Wheat Area, the Winter Wheat-millet Area, the Winter-kaoliang Area; the Yangtze Rice-wheat Area, the Rice-tea Area, the Szechwan Rice Area, the Double Cropping Rice Area, and the Southwestern Rice Area. The Wheat Region comprised first three areas while the Rice Region the last five. All the tables in Buck's statistic data[23] were strictly constructed under the frame of the eight agricultural areas, and so would this thesis adopt to recognize the distinction among these areas due to the *Geographic Physical Prerequisite* and on which the *Historical Inherited Convention*

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[21] "The influence of racial custom, at least, cannot be eliminated from any study of land use, and it may be greater than is generally surmised". "Turki, Mongolians and Tibetans in the northwest raise and consume more animal products than do the Chinese… tribes in the southwest raise corn in the mountains while the Chinese raise rice in the valley. Topographical differences no doubt account for this to some extent. But the freedom of the invading group…to select the sites for settlement in accordance with the suitability of the land for the type of agriculture to which it was accustomed, probably explains these differences seemingly due to topography." Buck, J. L. 1937. *Land Utilization in China* Chapter I: 5.

[22] Buck summaries some essential characteristics by contrast between the Wheat Region and the Rice Region: Proportionally, the productive uncultivated land is considerably greater in Rice Region than in Wheat Region because of more favorable climatic conditions. Modification of land is greater in Rice Region than in Wheat Region. Twice as many farmers own the land they work in Wheat Region as they do in Rice Region. Buck, J. L. 1937. *Land Utilization in China* Chapter II: 43.

Risk in farming is much greater in Wheat Region than in Rice Region due to the low and variable precipitation which limits crop yields in spite of the inherently richer soils. Buck, J. L. 1937. *Land Utilization in China* Chapter II: 45.

[23] Buck, J. L. 1937. *Land Utilization in China* – Statistics. Nanking: The University of Nanking.

was based.

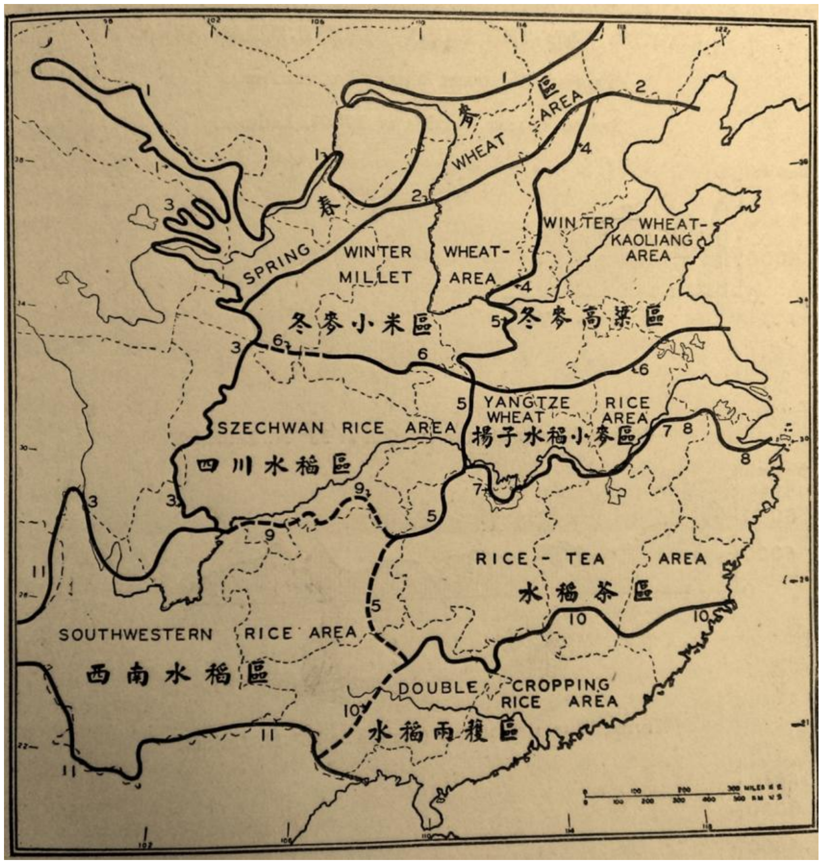

Illustration 2.2 Eight Agricultural Areas[24]

To evaluate farmland production was equivalent to assess the land utilization. Buck emphasized the necessary combination of *Geographic Physical Prerequisite* and *Historical Inherited Convention* when to analyze land utilization: "Some reformers assign most of the Chinese agricultural ills to a faulty agrarian situation… appraisal must take into account the basic or natural factors affecting both the type and success use of land, the factors determining the type of use of land and those factors responsible for the

[24] John L. Buck. 1937. *Land Utilization in China* Chapter II: 27.

degree of success in use of land”. Buck also reminded scholars the potential interaction between *Geographic Physical Prerequisite* and *Historical Inherited Convention*: “the vicissitudes of the Chinese climate make crop production hazardous— perhaps a little more so than on other surfaces of the earth of equal size. Such risks, however, can be minimized with a greater degree of economic organization, with better transportation and communication facilities, and with conservancy projects”.

A crucial interaction between *Geographic Physical Prerequisite* and *Historical Inherited Convention* was transaction cost that limited the diversification of production type for some specific location. For instance, bulky products of small value per unit of weight did not deserve to be shipped long distances. Great distances across the whole China with primitive methods for transportation, such as carrying goods by a pole over the shoulder, or by cart and junk, made access to markets a fundamental factor in determining the type of production. Though rail and steamboat transportation was increasing, predominant methods were still the laborious and inefficient ones.

Historically, convention also intervened with total amount and average crop production per unit area through keeping overwhelming percentage of crop area. Approximately 90% of farmland area was in crops, while merely over 1% in pasture land and wooded pasture. To the contrast, 42% of farm area in US was for crops, and pasture constituted 47%, almost reached a half and half balance. Herein denoted a much smaller animal industry in China and a consequent quite lower food consumption of animal products, as compared with those in many of the Western countries. Early Chinese civilization reported no evidence of greater animal products usage than for 1920-30s.

Excess reclamation was common in China, as artificial modification of land that had taken place more profoundly than in a young and less densely populated country like US. Cheap labor and high land value meant the land, which in other countries might be marginal for forest, or pasture, would be used for crops in China. For instance, rice had extended upon slopes of the hills which could be possibly better for other crops. People on these lands preferred rice to other crops basically in that their experience was restricted to rice, where the *Historical Inherited Convention* functioned. They planted rice on every available piece of land without sufficient consideration of any water supply, and some rice fields were even on top of a hill. Then the productivity would "depend upon heaven", namely every bit of water for such fields was from direct rainfall.

Tenancy system connected farmland property right with scale economy of crop production. Land was almost entirely privately owned, with merely 7% held by the State. Privately owned land was almost in the hands of individuals and over one-fourth was rented. Owner farms were larger than tenant farms, averaging 4.22 acres as compared with 3.56 acres. A little over one-half of the farmers were owners, less than one-third farmers were part owners, and 17% tenants. The extent of renting crop land was the benchmark to define the ownership type. For example, Farmers who owned their farmsteads, but rented all their crop land were classified as tenants rather than part owners. Tenancy was much more prevalent in south China than in north China and varied greatly in amount for different sections of the country from no tenants to all farmers as tenants.

Fragmentation of land, the ownership by individuals of scattered pieces of land, was the rule in China. Contrary to some countries such as England, where farmers seemed preferring to be tenants because they were thus relieved of certain responsibilities taken by landlord and could enjoy considerable security of tenure, Chinese farmers tended to be owners of land themselves to escape the fate of being slaves of some ferocious landlord. Whereas the first class of land[25] was limited to 52.1% averagely for China. To maximize the interest for large population of farmland owners who were simultaneously pursuing the good quality of land, fragmentation of land as *Historical Inherited Convention*, was the inevitable Nash Equilibrium for the game of farmland allocation. Objectively such fragmentation of land reduced efficiency of farmland productivity. It had disadvantages of increasing the number of boundary disputes, consuming time to reach the plots (nearly six pieces, or parcels, per farm averaging a little less than an acre in size), increasing the difficulties of irrigation, restricting the size of fields for machinery farming (also dense

[25] Classification of land quality by productivity references Buck, J. L. 1937. *Land Utilization in China*—Statistics Chapter II: 38, Table 9.

population made labor cheap and machinery operation uneconomical), and making integrated crop protection difficult. Chief advantage was, however from the perspective of risk management, one farmer might have land of differing qualities and this was vital in a country of small farms where a complete crop failure would be disastrous.

The loop of population and crop production exacerbated density of population and the predominance of crop productivity. On one hand, crop production was more intensive due to absence of hay and other fodder crops required for the animal industry as in Japan, India and even Soviet Russia, compared with that in most Western countries like US or Western Europe. On the other hand, double or even triple cropping on nearly two-thirds of the cultivated land was a way by which the Chinese have adjusted production to the density of population. Such trend and ascendant proportion of crops grown in turn indicated much more labor were required per acre, to meet the needs of an increasing population. Such loop further facilitated the monomania for the staple crop, the farming for seed or tubers until the possible greatest amount rather than to devote the land into pastures or crops for animals which in turn supplied a smaller quantity of food in a form of animal products. Moreover, land farmed for grains and tubers produced six to seven times the food energy as land used for raising dairy cows per unit, of which the difference encouraged grains and tubers growing on every possible inch to meet the bare subsistence needs of a dense population.

Unemployment did not prevent labor shortage during peaks of labor particularly at planting and harvest time. Hand methods impeded a more equal and smooth distribution of labor throughout the year. Labor saving devices for these peak periods would obliterate such difficulty and permit some farm population to have full time for other pursuits.

A particularly important characteristic of rural China was expenditures on celebrations, gifts, wedding and funerals etc. These expenditures required ready cash for conspicuous delicacies that enriched diet on festive occasions, for utensils and wearing apparel, for tobacco or other luxuries, for schooling and recreation, for weddings and funerals, and for religious observances. Farmers sold the superior cash crops like tobacco, opium, peanuts, rapeseed, cotton, cocoons or raw silk and cereal crop like soybeans or wheat, while consumed inferior grains themselves, like kaoliang and sweet potatoes. Without the need for such price gap, agriculture in China could be much more self-sufficient than in any Western country; yet still China had a highly developed civilization to both satisfy home necessities and show off social status or family prosperity. Chinese farmers thus developed innumerable cropping systems to produce variety of crops required and to utilize his labor throughout the growing season. Some of these systems were suggestive as international advanced for adoption in other countries having similar climatic, soil, industrial level and market conditions.

Since most of the Chinese were farmers and most of farmland area was in crops, frequency of crop failure was an indication of land utilization performance. Risk of farm management chiefly existed in calamity prevention and mitigation— irrigation control, culminating in drought or flood— "is a major problem and its removal will do more to increase production than any one other thing". Irrigation, as the paramount ***Current Artificial Temporal***[26], was the device farmers mainly resorted to for offsetting the aftermath brought by drought. The feeble performance of irrigation accounted for the severe absence of comprehensive and progressive irrigation facility in general and even conversely hinged on the prices of agricultural products. During drought years before 1932, farmers themselves undertook the task of digging canals for irrigation. After 1932, prices of agricultural products decreased though taxation of irrigated land had increased, thus the opportunity cost of irrigation increased and resulted in irrigated land being abandoned. Hence slim achievement of irrigation on boosting productivity with the counteraction from the prices of agricultural products induced that calamity still stood as the chief menace for agricultural production. In such case, impact analysis of ***calamity factor*** onto crop production would be the highlight in this thesis.

Animals were generally treated as farm labor instead of either source for meat industry or fertilizer productivity. Density of animal population, contrary to the lack of animal industry, was quite high over large part of the country. Farms were moderately

[26] "Among the changes made to land by man in China, irrigation and terracing are the most important." Buck, J. L. 1937. *Land Utilization in China* Chapter VI: 186.

well-stocked on animals, in spite of the fact that 10% of the farms had no animals at all. Big animals were usually deemed as loyal partners on farming to each family, thus farmers seldom killed them except being driven to desperate.[27] Each family kept a couple of big animals on average and such animal labor can be even shared between close neighbors. Therefore limited amount of animals contributed finite fertilizer. Apparently, increased implement of fertilizer would be profitable, but insufficient capital and unavailable fertilizer by machinery production obstructed such development.

Size of farm and optimized size for crop production was a topic Buck had been focusing on. First, large farm had the economy of scale. Dense population utilized less proportion of cultivable land for crop production rather than more. Housing and farm administration severely swallowed acreage of small farm where it was most needed. Large farms had advantage over the small farms also in that parcels and fields were larger and the crop acreage per man-equivalent and per labor animal unit were 2.5 times as great. Second, size of family was tightly positively correlated with size of farm. Third, smaller size of farms induced few animals per farm. The average size of farms in Wheat Region

[27] The extent of this can at times be best understood from literature. Pearl S. Buck, the Nobel Laureate author of *The Good Earth* was John Buck's wife and frequently travelled with him to the countryside. Her perspective on this was reflected in her novel about rural China: *When the famine came, Wang Lung "kept the ox on the threshold until it grew lean as its skeleton… But there came a day when there was no rice left and no wheat left… the old man said, "We will eat the ox, next." Then Wang Lung cried out, for it was to him as though one said, "We will eat a man next." The ox was his companion…from his youth he had known the beast, when they had bought it a small calf. And he said, "How can we eat the ox? How shall we plough again?"… But the old man answered, tranquil enough, "Well, and it is your life or the beast's, and your son's life or the beast's and a man can buy an ox again more easily than his own life."… He said roughly, "Let it be killed then, but I cannot do it*." Buck, P. S. 1931. *The Good Earth*: 71-72.

of 3.56 acres was larger than in Rice Region of 2.27 acres inasmuch as less favorable climatic conditions, primarily a shorter growing season and a more variable climate. The most economic-sized farms would be in the very large size-group on a scale of 13.02 acres of farm area; of 3.7 man-equivalents; of 3.02 animal units; of 2.25 labor animal units; and a production of 10,376 kilograms of grain-equivalent per farm, when all the farms were grouped into five size-groups.[28]

Trends in the Chinese price level had influenced the intensity of land utilization. China set the currency on the silver standard for a long time until late of 1935. From 1885 to 1931 silver fell in value compared with all other commodities due to the world demonetization of silver; and price level rose quite rapidly since in China prices were measured in terms of silver. Consequently, silver hoarding began in 1931 as well as gold hoarding during monetary difficulties in gold standard countries. Then a rise of silver value and a fall in prices came, which resulted in the Chinese depression which lasted until devaluation and the establishment of a managed currency on November 3rd, 1935. At first the rising prices caused agricultural commodities and other raw materials to rise in price more quickly than other groups. Wages lagged in the rise to make it profitable to apply comparatively more labor and fertilizer to increase production. In other words, rising prices made more intensive farming possible. Falling prices, however, had the

[28] The criterion of measurement for size is vague, and the exclusive known is the designation for these five groups: small, medium small, medium large, large, and very large. Buck, J. L. 1937. *Land Utilization in China* Chapter IX: 287.

opposite effect because agricultural prices as well as prices of other raw materials fell first, and most rapidly. Other costs, such as labor and taxes, lagged in their fall. Therefore costs of production were high and must be curtailed especially in view of the low prices received. Production thus shrunk.

Buck suggested a series of criterion to measure the success of farmland utilization, such as yields, production per capita, wage of farm labor, taxation of land, the standard of living (the amount and ratio of debt and savings as a measure of adequacy) and population density… "In general, China's yields are better than those of India or Russia, not as high as those of Japan, and are less favorable than those of Italy, Germany, Great Britain, and the United States. Floods, droughts, soil erosion, insufficient fertilization, absence of control of insects and diseases, and inferior seeds are among the factors accounting for this situation". Further improvement of yields could stem from adoption of modern transportation, economic organization and technical promotion in agriculture.

2.4 Summary

Observation of agricultural production are scattered and hidden within volumes of Buck's academic composition. The aim of this literature review is to search for as many clues as possible and dig them out to construct a frame for expounding what were the prime factors that affected the agricultural productivity and how each factor worked.

All factors are sorted into three groups by the author in this thesis: ***Geographic Physical Prerequisite***, includes climate, topography and soil; ***Historical Inherited Convention***, includes the type of the land use (excess reclamation, fragmentation), the tenancy system, racial custom (ready cash for conspicuous delicacies on momentous occasions, dense population), and the prior sales channel, etc; and ***Current Artificial Temporal***, includes irrigation system, animals as labor and offering livestock waste as fertilizer, size of farm, and trends of price. Calamity, such as flood, droughts, famine, wind, frost, hail and even insects, can be triggered by any factor in either group or in combined groups and it is supreme in this thesis because China was exposed to frequent catastrophes so severe that those calamities undoubtedly exerted an important effect on reproductive performance.[29] Some factors are across-group: Transaction cost was shaped through both *Geographic Physical Prerequisite* and *Historical Inherited Convention*. People in Rice Region had become so habitualized to rice that they continued to make it the chief staple of their diet, even when it was more expensive than wheat. This is the case how *Current Artificial Temporal* converted to *Historical Inherited Convention*.

Besides what are emphasized above, other supplementary explanation of farmland productivity should be mentioned: Official statistics were unreliable because land area was often misrepresented by the owners to evade taxes, and newly reclaimed lands might

[29] Buck, J. L. 1937. *Land Utilization in China* Chapter XIII: 381.

not be reported. Land surveys in several hsiens had shown the error in reported cultivated area reached as much as one-third from the actual number.[30] Tax rate, surprisingly, had little correlation with land productivity but was controlled by the political administration within each hsien.[31]

Grave land constituted a real problem in densely populated China, and stressed by Buck in every of his essays, not only because the land was taken away from cultivation, but also in that graves created obstacles for scale management. If those graves could be removed, crop area in China would increase by 1.1% or 2,552,000 acres, which could support over 400,000 farm families. Within the area of grave land, more than half, 64%, was in cultivated fields, 15% in arable uncultivated land, and 21% in non-arable land. Regionally over four-fifths of the grave land in Wheat Region was in cultivated fields, while less than one-half in Rice Region since quite amount of graves were settled in accessible hill and mountain areas.[32]

Tenancy system is indispensable as *Historical Inherited Convention* and the rent reflects average yield. But rented area accounted for merely over one-fourth of the farmland. By regional comparison, ownership was more prevalent in Wheat Region where one-eighth was rented than in Rice Region where two-fifths was rented.[33]

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[30] Buck, J. L. 1937. *Land Utilization in China* Chapter VI: 162.
[31] Buck, J. L. 1937. *Land Utilization in China* Chapter VI: 171.
[32] Buck, J. L. 1937. *Land Utilization in China* Chapter VI: 178.
[33] Buck, J. L. 1937. *Land Utilization in China* Chapter VI: 194.

Preference of Chinese farmer for crop growing visibly reflected the sequence of desirable characteristics, high yield ranked first, and early maturity was the next in importance.[34] Cropping system, or rotations of crops, comes from the experience that better yields were usually obtained by alternating crops instead of growing them always on the same land. It was the yield and the price of crops, seasonal distribution of labor and proportion of the most profitable crops together that determined the profitableness of a cropping system. To boost output, better care of the crops was necessary, such as improved fertilization with nitrogen and phosphorus, irrigation, drainage, control of flood, control of insects and disease, and pruning of fruit trees. To be specific, Rice region suffered mostly from insufficient capital while Wheat Region insufficient fertilizer.[35] Extending credit at reasonable rate to farmers for purchase, generalizing of modern transportation to decrease transaction cost, and discovery of sanitary use for night soil without diminishing the fertilizing value were solutions to fertilizer problems in China.

For an individual, a farmer was better off living in a more densely populated area with better yield because of the more favorable conditions for agriculture. However, to the entire farmers in China, the true cause for low standard of living as compared with US was the low production per man-equivalent, which explained why the one-quarter of the total farmers in US provided more agricultural products per capita than three-quarters

[34] Buck, J. L. 1937. *Land Utilization in China* Chapter VII: 221.
[35] Buck, J. L. 1937. *Land Utilization in China* Chapter VIII: 260.

of the total Chinese farmers could.[36]

As farmland value, income from agricultural production sales was disturbed by currency trends. Gradual decline in silver value, expressed in a rise of prices paid by farmers for commodities consumption of living and production, in wages, in prices of labor animals, in farmland taxes, during the period from 1888 to 1931, exerted a substantial influence onto the farming prices expressed in terms of silver.[37] Before the year 1925, the rise in farmland value was about equivalent to the reduction in value of silver currency, but after 1925, farmland value did not rise because of a diminished demand for land owning to agitation against landlords and confiscation of land[38] launched by Chinese Communist Party to recruit armies in the aim of supporting the Northern Expedition to overthrow the governance of the Northern Warlords. Earnings from output sales fluctuated synchronously.

Transaction cost induced higher price of grain several months after harvest. Grain was with higher moisture content immediately after harvest than later, hence dehydration and storage of products begot an expense, and losses might occur through insects, rodents, dampness, fire and theft. Sometimes price was high enough to enable the person holding grains for profit regardless of the storage risk. Scale economy of transaction cost rooted

[36] Buck, J. L. 1937. *Land Utilization in China* Chapter IX: 283.
[37] Buck, J. L. 1937. *Land Utilization in China* Chapter XI: 345.
[38] Buck, J. L. 1937. *Land Utilization in China* Chapter XI: 347.

in that local transportation would cost even higher than longer distance transportation did since shipment in larger quantities for longer distance was cheaper. Competitiveness of China was undermined due to the high transportation costs and heavy tax levy on agricultural produce, compared with foreign countries exporting agricultural products to the mainland.

Following this review of the literature a variety of control variables are selected to capture agricultural productivity. Although Buck provides many variables in the same class, multicollinearity forced us to use only a limited number of key variables that Buck deemed important. These include farm size to capture potential economies of size and scale, distance between farm parcels to capture land fragmentation and diversification, human labor invested in marketing to capture transaction cost, irrigation, and percent of arable land to capture land quality. The dependent variables in our analysis are the actual productivity (indexes) as reported in the survey period and the ratio of these productivity measures to normal yields and best yields. Dummy variables for location of village in agricultural areas, provinces as well as time period of survey are included to capture the broader effects. And it is these variables combined with calamities and conflict that is most interested. The regression coefficients and tests in Chapter 5 would be applied to interpret marginal changes in designated relationships, for instance, how much influence an event such as Yangtze River flood in 1931 had imposed on yield oscillation through location and time. Current affair remarks derived from news in *China Weekly Review* is rearranged in Chapter 3. More detail of variable generating and selection can be traced in Chapter 4, Data and Method.

Chapter 3: CALAMITIES AND CONFLICTS

In the previous chapter certain aspects of the agricultural economy in China were reviewed as described in Land Utilization in China. However, if land use in China is to be criticized it is that Buck never placed any of the statistical data in context. In other words farm productivity in Shensi in 1929 and 1930 was treated no different and without qualification to say Hunan in 1933. This is believed to be a material oversight. China between 1929 and 1933 was in tumult from a variety of natural calamities and manmade conflicts and each of these in one way or another can qualify the data. For example reports in August 1930 stated that under current conditions massive amounts of land were being underutilized. Floods, insects, drought, wars, banditry, and communist disturbances were forcing farmers to leave land uncultivated.[39] Of those that remain on the land the vast majority did not have the scale to adopt new technologies that could improve yields, they consumed their own stocks in times of crisis therefore depleted supply available for general consumption. Furthermore, the calamities and conflicts on which this chapter report have much broader economic consequences. For example, while there was probably enough rice land in China to feed the world, there was in 1930 a shortage which encouraged hoarding behavior driving the price up to the highest levels ever

[39] Shen, Chennan. August 16th, 1930. Is China facing Starvation? *China Weekly Review* vol.53: 422-423.

recorded ($24/200 lbs or per "shih"). Due to famine and war, the lack of shipping and transports limited importation of commercial or relief grain into depressed areas which exacerbated conditions, while in all areas the rapid rise in price reduced the consumption especially for poorer households that relied on rice as a staple. In Shanghai dock workers and factory workers went on strike in order to get a "rice allowance" added to their wages.[40]

The costs of militarism on agriculture can also not be ignored. In Kiangsi alone the losses due to militarism between 1926 and 1931 were 6,600 houses burned with 22,600 casualties and property damage of $5 million; in Kweichi 3,000 houses were burned with 60 casualties and $400,000 for property damages; in Yichuan 700 houses were burned with 100 casualties and $20 million for property damages; in An-fu 5,000 houses were burned, with 7,000 casualties reported but property damages for only $35,000. The list goes with maximum property damage of $40 million in Kwungfeng, 8,000 houses burned in Yinshin and 22,600 casualties in Shuichan.[41]

Yet, other reports show advances to agricultural productivity with certain aspects of militarism, especially those related to communist activities.[42] To the peasant class many of these were attractive elements especially those related to the redistribution of land and

[40] Lee, B.Y. August 16th, 1930. The Rice Situation and China's Welfare. *China Weekly Review* vol. 53: 419-420.
[41] Chia, Hsi-yen. January 3rd, 1931. What Communist Bandits have done in Kiangsi. *China Weekly Review* vol. 55: 186-187.
[42] Chien, Yang. July 25th, 1931. Canton Rebellion Likely to Throw All China into Ranks of Communists. *China Weekly Review* vol. 57: 297-300.

working conditions so it is no wonder given conditions in the rural areas that the communists could attract members and forces. Even so, context matters. For example while the communists in establishing a soviet eliminated all forms of taxation, this was unlikely to be economically neutral for often the tax on grain was in physical commodity and not cash, and what was taxed was consumed without being necessarily sold in the cash market. Consequently, to fund activities, systems of fees and surcharges were put in place in addition to the forced surrender of grain when needed.

For our purposes the activities related to agrarian reform were so sweeping that they cannot be ignored. On one hand is the militarism itself which can not only destroy crops and dislocate farmers, but the commandeering of trains for troop transport meant less freight for shipment of grains and produce to markets, contracts with middlemen could not be guaranteed for delivery, and so on. But it also meant that with thousands of farmers joining the red army, labor productivity would decline or wages would have to increase accordingly. In areas with large tenant populations it was unlikely that landlords would keenly invest in inputs and improvements if there were a risk that lands and titles would be confiscated and redistributed to peasants and soldiers. Credit, were it available would melt away with declarations that all notes bearing high interest and pawn shop tickets, and therefore would be considered null and void.

On the other hand improving the farm economy by farm reconstruction, improvement in irrigation, prevention of floods and droughts, support emigration to reduce farm population density, establishment of Farmer's Banks and cooperative societies to provide credit on easy terms, unify currency and weights for measures, and maintain efficient control of waterways were all designed to improve agricultural conditions and productivity. In Kiangsi much of these reforms were put in place including the removal and burning of all deeds and the removal of boundary markers to destroy all evidence of ownership boundaries. The land was redistributed to the able-bodied regardless of sex, and additional land was allocated to households for persons with disabilities and children under age of 16 by up to 25% of the normal allocation for the household. To aid in recruitment, land held by soldiers of the Red Army would be tilled by others. The labor class including poor and middle poor peasants and workers were organized into unions. The middle and upper class gentry were excluded from all political activities for fear they would manipulate a class struggle in order to get land back. The bandit class, including the various societies (small sword, red spears etc.) was absorbed into the soviet and the military so long as they renounced any authority other than the soviet. In doing so the communists removed a significant element of banditry.

In economics the term ceteris paribus means other-things-being-equal and in some instances principles of homogeneity are appropriate. But in Buck's study with various villages being surveyed at different locations with different exogenous factors to interpret the data as if all other things were equal is likely to be incorrect. For example except for one village surveyed in Liaoning there is no observation that might provide insights into the impact of productivity on agriculture following the Japanese annexation of Manchuria and provinces north of the Great Wall between 1931 and 1933, nor is there any observation of villages in the battle zone around Shanghai during the Sino-Japanese conflict in January to March, 1932. To add complexity many of the village names no longer appear in current maps or have been changed so that it is not possible to readily pinpoint precisely where a particular village was located. The Analysis of Covariance approach used in the chapter of results and analysis bears this out: not all provinces were in conflict and not all provinces met a calamity. In addition from a point of methodology it is highly unlikely that the villages surveyed were truly representative, nor would Buck have sent his students and surveyors into areas controlled by warring bandits, warlords, communists, or nationalists for safety reasons. Further, not every particular village was known when it was precisely surveyed. So if it was in a war zone it might have been surveyed before the war, after the war, or during the war if it was some safe distance from the front lines. If the randomized survey protocol was indeed practical, the ceteris paribus interpretation of the results could be rested on with some sense of confidence. Because such doubts are open to question, results must be interpreted in the context of the historical developments at the time.

The empirical part of this thesis is essentially geared to understanding how calamities and conflicts and other natural and geopolitical influences can collectively or individually explain the productivity measures in Buck's study. Context, as it is argued, matters. In the empirical section regressions are first run while considering the inputs to the production process, the agricultural area, the province and the time at which the survey was conducted for each village.

The time span at which each village was investigated is provided in the statistical appendix to Land Utilization in China but little mention of the dates appears in the actual text book. Thus without context a reader of Land Utilization in China might naturally assume that productivity in Shensi was lower than that of some other province without fully comprehending that Shensi was in the midst of a drought and famine that was unparalleled in decades; or some other province was surveyed after a massive flood; or some other village was inundated by communists, bandits, warlord armies or nationalist forces fighting these groups, nor are conditions given to explain the geopolitical differences across provinces. Indeed, Buck focused differences in productivity according to agricultural zone, whereas our findings will show that the significant differences in productivity are tied to provincial matters.

To investigate this, our regressions use productive controls, and a series of dummy variables to capture the time frame, provincial and agricultural regional factors. In addition, then a number of variables are added to apprehend the flood, drought; communist, bandit, warlord, other civil military activities, and Japanese militarism and other factors. But before presenting these econometric results, the remainder of this section summarizes by year the various calamities and conflicts across China at the time Buck's survey was taking place.

This summary is almost entirely reliant on the contemporaneous news reported in the weekly volumes of *China Weekly Review* (CWR). The benefit of sourcing history from CWR is that it provides continuity of depth on any particular issue drawing from its own reporters and editors as well as other contributions from Chinese and English (and Japanese) language dailies and weeklies. It would also pick up on regional news sources as well as news items of national importance. On the other hand it is unlikely that the news made available is entirely complete. Banditry and civil wars that could easily lay waste to large sections of agricultural land might not always be reported. In other instance it might simply be a 25-word statement that some village or region was invaded by bandits or warlords. However, if any such action rose to some serious threshold in all likelihood it was reported and recorded for our purpose. Nonetheless, while it is believed major calamities and conflicts facing rural China are all caught between 1929 and 1933, it is more than likely that there were many incidents not recorded for one reason or another. In the following paragraphs the various calamities and conflicts were obtained almost exclusively from the contemporaneous reporting in the *China Weekly Review*.

3.1 Flood, Drought, Pestilence and Famine

The most significant calamity of 1929 was the on-going drought in China's north and central provinces including Shensi, Shansi, Honan, Kansu, Suiyuan, Chahar, Shantung, Hopeh, and Hupeh. Initial reports in December 1928 of a famine arising in Shensi resulted from drought. The rivers Wei and Kin were drying out with reports of plague and locusts. 91 districts were affected with reports of young girls being sold for marriage at a price of $4-5. At Kuanshien in Shantung 100,000 reported as being destitute. The China International Famine Relief Commission reported that in one hsien in the area between the Yellow River and Sianfu in Shensi, 70,000 of 120,000 were completely destitute of foods or substitutes with the remainder living on meager diets. Dried grasses were being grounded with which to make a sort of porridge. Draft animals had disappeared having been eaten. In one district 100 families committed suicide rather than continued to suffer.[43] Edgar Snow provided the historical context of the disaster unfolding. Approximately 50 million persons were affected by the drought and famine in Shensi, Honan and Kansu an area that was relentlessly impacted by a host of calamities including the "quintet" of drought, famine, flood, earthquake, and locusts. The range of

[43] Editorial. February 23rd, 1929. *China Weekly Review* vol. 47: 519.

calamities and conflicts affecting China since 1850 included 1850-1864 Taiping Rebellion with 20 million killed and 9 provinces decimated; 1878 Famine in Shensi and Shansi with 8 million dead; 1894 war with Japan; 1899 Severe drought in Shensi; 1923 drought and famine in Shensi and Honan; 1923 earthquake and mountain slip in Kansu, killing 200,000; 1924-1929 continued drought and famine in Shensi, Honan and Kansu.[44]

And from personal observations in Kansu, only in the valley of the Yellow River were crops normal. In other sections crops were poor but if rationed properly could have been sustainable. In other locations the crops were devastated and without a precautionary stock, famine took hold very quickly. Harry Paxton Howard wrote "*Throughout this vast territory conditions are such as are unknown and incomprehensible in modern countries today. From eating bark of trees, grass roots, and vermin of every available kind, the starving people have gone on to eating what they hopefully call 'bread-stones', which are simply a kind of rather solid clay with no food value whatever. Finally has come cannibalism, and the emaciated bodies of the dead are consumed to maintain, for a little while, the spark of life in the living…There is cannibalism over most of the province at present but particularly in the south. Not only the emaciated dead are eaten, but sometimes nourishing victims are found. A detachment of 10 of Col. Chao Si-ping's soldiers, near Lingshih, failed to reach a city before dark, and slept out in the*

[44] Snow, E. December 15th, 1928. China's Five Horrors. *China Weekly Review* vol. 47: 122.

open. It was their last sleep, as about all that was left of the detachment in the morning were gnawed bones and some clothing. They had been eaten."[45] Edgar Snow, visiting the famine regions in Suiyuan in Inner Mongolia observed "*...stepping over a skin-draped skeleton in which a faint agitation told that life still loitered, as though waiting for an unseen hand to order it to shuffle away forever… a withered young woman who was frantically burrowing a hole into a little mound of earth, digging for the roots of a leafless, almost limbless, dust coated tree that somehow had managed to escape complete dismemberment…A family group...spent a week in tramping across the dusty semi-desert of the southwest…there were four sons each with 12 mu of land, enough to support the family… to keep from starving they ate their seed grain. An opportunity came to sell their women and girls to wealthy Chinese in the east, rather than watch them starve to death, they agreed to the deal…It was almost unbelievable that human beings could survive with so little flesh clinging to their frames… one fellow-the ghost of a once powerful man, was particularly pitiable. The muscle had dropped away from his broad shoulders and stout arms; one could have joined the fingertips of one's two hands around his waist, and encircled his biceps with the thumb and forefinger of one hand. They all wore such rags that the greatest mystery was how the countless tatters managed to hang together as one garment…. signs of famine disease. Their faces were puffed like bloated sausages, and in*

[45] Howard, H. P. June 1st, 1929. Famine and "Mohammedan" Banditry Again Devastating Kansu. *China Weekly Review* vol. 48: 17.

color their skin was like stagnant water. Their eyes, in which lingered no trace of the alert curiosity so characteristic of Chinese children, were watery and sometimes almost obliterated by the bags of mottled flesh that surrounded them."[46]

By May in 1929 however, the full extent of the drought was recognized. Famine conditions in China were affecting about 10 times more people than the past major famine of 1920-1921 and the entirety of shipments of grain into the famine areas ending on April 1st of 1929 was less than the amount of grain moved from Manchuria in each week of the 1920-1921 famine. In the famine regions of Hopeh and Shantung grain was moving elsewhere than Manchuria and assistance was mostly financial with local agencies purchasing the required grain. But in other provinces where grain was not to be found the money was useless for without grain being shipped it could not be purchased. Relief was not effortless. The China International Famine Relief Commission (CIFRC) leased locomotives and cars for relief purposes and were given assurance by local military that famine shipments would travel without incident.[47]

Into 1930 conditions improved in many areas but not for Shensi. In June of 1930, the CIFRC reported a wide-spread drought in Shensi was requiring burial squads to make two rounds per day in Sian. Up to the Sanyuan plain in Shensi, there was only 5% yield

[46] Snow, E. August 3rd, 1929. Saving 250,000 Lives. *China Weekly Review* vol. 48: 418-424.
[47] Clark, G. May 18th, 1929. Famine Relief in North China. *China Weekly Review* vol. 48.

on crops and poor conditions were also reported in western counties.[48] In addition there were also reports of a serious famine in the eastern part of Chekiang requiring massive food aid.[49] In the district of Paotachen, Suiyuan province, already under famine conditions, crops were damaged from a rare summer cold spell that dumped up to 6 inches of snow in June.[50] In 1931 famine conditions were reported in west Honan and Kansu.[51]

With an unusual warm March weather increased the current of the Yellow River in Tsinan became so strong that it breached a dyke at Litsin hsien, resulting in damage to 100 villages with tens of thousands of farmers affected and sheltering on the dykes.[52] In August 1929 rains in north China caused the Yungting river to overflow, inundating 10 villages flooding 200 sq miles of land with many persons drowned as well as thousands of cattle and all crops lost. The floods affected nearly 500,000 people who in great starving numbers were living on the sides or tops of hills. Efforts at relief were hampered by the enormity of the flood and the isolation of the villages and the stranded.[53] In Shantung a 1,000 ft breech in the Yellow River flooded a strip of land 50 miles long and

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[48] Editorial. June 14th, 1930. Acute Famine Conditions in Shensi Province. *China Weekly Review* vol. 53: 57.

[49] Editorial. June 21st, 1930. Famine Conditions in Chekiang. *China Weekly Review* vol. 53: 110.

[50] Editorial. June 28th, 1930. Summer Cold Wave Hits Suiyuan Province; Crops Damaged. *China Weekly Review* vol. 53: 147.

[51] Editorial. April 4th, 1931. Banditry and Famine in Honan. *China Weekly Review* vol. 56: 156; Editorial. April 4th, 1931. Hunger in Kansu Drives Population to Cannibalism. *China Weekly Review* vol. 56: 157.

[52] Editorial. March 16th, 1929. Warm weather Causes Breach in Yellow River Dyke. *China Weekly Review* vol. 48:120.

[53] Editorial. August 3rd, 1929. Ten Villages Flooded in Chihli. *China Weekly Review* vol. 48: 446; Editorial. August 17th, 1929. North China Areas Devastated by Floods. *China Weekly Review* vol. 48: 529.

10 miles wide, destroying the bean and grain crop in an already famine ridden area for which the destroyed crop was a promising aid.[54]

In June and July of 1931 the China Weekly Review posted two short articles that were prescient. On June 13rd of 1931, in one of the first signs of the disastrous flooding to engulf the Yellow and Yangtze River basin, northeast Hunan was inundated with rainfall.[55] Landslides were reported and rainfall from the mountains was so intense that debris covered the valley for several square miles. Many lives were reported lost and crop losses were immense with newly sown fields laid to waste. The second, on July 4th 1931 discussed improved production in many areas of China.[56] Despite the drought of 1929 and its residual into 1930 and various civil wars and strife, the agricultural outlook for China was projected to be the largest crop ever. North of the Great Wall in the spring wheat area production was projected to be 146% of normal yields with yields in Heulungkiang being 171% of normal. Winter wheat in the southern provinces of Shansi (49%), Hopeh (74%), Shantung (105%), North Kiangsu (92%), Anhwei (74%), Honan (87%), Hupeh (79%), and Kiangsu (71%) were expected to be lower (86%). Although crop conditions were good in Shantung, Hopeh and Honan, fewer acres were planted in Hopeh and Honan due to poor weather conditions and warfare.

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[54] Editorial. August 31st, 1929. New Floods Reported in North China. *China Weekly Review* vol. 50: 14.
[55] Editorial. June 13rd, 1931. Terrific Rains in Hunan. *China Weekly Review* vol. 57: 69.
[56] Editorial. July 4th, 1931. China's Wheat Crop for 1931 Estimated at 600,000 Bushels. *China Weekly Review* vol. 57: 195.

Optimism about bumper crops was soon to be dashed by the great floods of the Yellow and Yangtze Rivers. On July 11th there were reports of serious flooding across China. The west and north rivers at Kwangtung had overflowed their banks and the Yungting and Taching rivers in Tientsin were similarly inundated. In Kiangsu the Grand Canal had risen 10 feet and had submerged several villages. In Eastern Honan near Tangshan the Yellow River was overflowing and flooding large sections of farmland. Refugees were already beginning to congregate on nearby hills. Heavy rains in Nanking saw several buildings collapse.[57] On July 18th of 1931 it was reported although conditions had become less serious in many places which had been affected, rail traffic was disrupted by excessive flooding in Honan with one train wrecked when the road-bed gave way.[58] In north Kiangsu one district was turned into a lake as the consequence of continuous downpour. Water on the streets was knee deep and most houses submerged. Elsewhere in Kiangsu the dykes at Tsingkiangpu and Chuchow collapsed flooding rice fields with damage estimates of $6 or 7 million. The Huai River had risen 20 ft and in peril of inundating many districts in northern Ahnwei if the weakened dykes failed. On July 7th most of Peiping was under water and electricity was cut out putting most of the city into darkness. Along the Yellow river, which had risen to 85 ft above sea level, dykes and embankments collapsed in both the upper and lower parts of the river. In Pengpu a

[57] Editorial. July 11th, 1931. Serious Floods in Many Parts of China. *China Weekly Review* vol. 57: 242.
[58] Editorial. July 18th, 1931. Floods Cause Disaster in Many Parts of China. *China Weekly Review* vol. 57: 276.

dispatch dated July 13th stated that after 10 straight days of heavy rains the city was several feet under water with boats moving goods and people around and 5,000 people were homeless. On August 1st, 1931 widespread flooding in Nanking was reported with 1,000 houses collapsed due to heavy rains.[59] Conditions in Kiangsu were so severe that famine conditions would be confronted in the fall. Near Wuhu in Anhwei province the collapse of embankments flooded 200,000 mu of rice fields. Farm houses collapsed and many livestock drowned. Wuhu was also flooded. Reports of flooding in south Shantung followed heavy rains on July 16th combined with hail. Many cities along the Shanghai-Nanking railway were flooded. At least 30 % of rice fields were damaged and granaries were washed away requiring sampans (river boats) to be used for storage. The Chientang River in Chekiang province was on the verge of overflowing due to heavy rains and many districts inundated with flood waters. On August 8th of 1931 it was reported that the Yangtze River near Wuhan flooded drowning several hundred people on August 1st.[60] A Dam at Hankow collapsed on August 2nd and hoarding and profiteering in coal and foodstuffs was outlawed. In Anking, losses in 39 districts exceeded $4 million but with a provincial deficit already a ban on the export of rice was imposed. The Yellow River in Shensi broke its banks and flooded a wide area in Pingmin. In Tsingyuan, about

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[59] Editorial. August 1st, 1931. Central Government to Grant Relief to Flood Stricken Areas. *China Weekly Review* vol. 57: 364.

[60] Editorial. August 8th, 1931. Nanking Relief Committee Investigates Flood-stricken areas. *China Weekly Review* vol. 57: 406.

60 miles northwest of Canton 1,297 persons were drowned, 10,000 persons rendered homeless, 36 fish ponds ruined, 25,000 mu of land damaged and losses totaling some $2 million. In Hunan, General Ho Chine, Chairman of the provincial government ordered all slaughterhouses to close for one day so that the wrath of Heaven might be appeased and the people spared. By August 15th of 1931, the full scope of tragedy was being realized as potentially the worst flooding since the 15th century with much of central China flooded including Hupeh, Hunan, Kiangsi, Anhwei, Szechwan and Shangtung hit the hardest.[61] The General Relief Committee at Nanking reported that some 50 million persons were in distress and 16 provinces were affected by floods. They petitioned Nanking for $20 million for relief and another $5 million to be raised in Shanghai ($25 million). As at August 11st, the Grand Canal had not yet burst but the Kiangsu provincial government was alarmed by the rise of water. Starving peasants in the vicinity of Kiukiang were reduced to selling their oxen and buffalo for $4 and $5 each to buy food for themselves. Although water was receding all hopes of a harvest were lost. 220,000 in Hankow were rendered homeless. It was observed that peasants removed bodies from un-interred into coffins in order to transport themselves from one place to another. Because of water levels ships could not be unloaded at Hankow. Tugboats used for temporary storage and

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[61] Editorial. August 15th, 1931. Fifty Million in Distress as Result of Floods. *China Weekly Review* vol. 57: 431; Editorial. August 29th, 1931. Flood-Famine Situation Most Serious China Disaster since Fifteenth Century. *China Weekly Review* vol. 57: 495-499; Editorial. September 5th, 1931. Further Areas Inundated in Kiangsu-Gen. Chiang Inspects Hankow Flood District. *China Weekly Review* vol. 58: 7-13.

food shortages in Wuhan forced the Hupeh government to telegraph Kiangsi for an immediate shipment of 100,000 piculs of rice. Flood damages in Hupeh, Hunan, Kiangsi, Anhwei, Kiangsu and Honan estimated at $8 million and in Kiangsi some tax relief on arrears was provided to farmers.

By October in 1931 the floods had subsided in most parts of central China but too late in many cases for planting a winter crop. Land could take years to reclaim so the outlook for 1932 was not expected to be high. And yet the calamities in 1932 and into 1933 continued with famine and drought continuing in Shensi, more flooding in Hunan and Kiangsi, cold and drought in Kansu, flooding in Harbin of Manchuria, drought in Anhwei.

3.2 Bandits, Warlords, Civil War and Agricultural Conditions

Banditry was rampant across China. In a letter to the editors of CWR John Lossing Buck wrote of meeting farmers in a tea house to discuss credit cooperatives.[62] A farmer said "*if any financial help is rendered to us now, it would only bring more harm than good, for our greatest distress and sorrow is no other than the bandits. We can neither work in the daytime nor rest at night…well-to-do families have taken refuge in the city. Those who are poor…hurry away and hide with their children wet and cold, in the bushes*

[62] Buck, J. L. December 15th, 1928. Letter to the Editors. *China Weekly Review* vol. 47: 73.

and streams of the mountainside in spite of the mosquitoes and snakes…many deaths have occurred. We do not grieve over the dead, for it is better to die of sickness than to be killed by bandits…we would rather die than suffer".

Bandit forces arose for many reasons. In some instances it was the inability of the economy to absorb soldiers being released as the national government was trying to disband its numbers after the northern expedition to eradicate the northern warlords between 1927 and 1928. Other bandit forces were remnants of former warlords, or by warlords that escaped the Nanking forces.

In many rural areas remnants of the Boxer societies still persist along with the superstitions in China. In Honan at least 3 secret societies prevailed.[63] The Heavenly Obedience Society was formed in 1925 by a Wang Lao-feng who declared that he was the "Real dragon" and would soon be China's emperor. That organization comprised of many women as well the structure was the leader and then male and female military commanders. Believing in special powers in charms and spells they decided one day that that Ki hsien would be their capital but were badly beaten and dispersed with members becoming bandits or joining other societies. The Heavenly Gate Society was formed by Han Yu-ming, a stone cutter, who found a stone seal and pretending that he cut it from a large stone established an alter at which he referred to himself as the Old Corps Tutor. He

[63] Loo, M. M. April 6th, 1929. Some Secret Organizations in Honan. *China Weekly Review* vol. 48: 248.

convinced members that they were immune to gunshots and rousted a city from which he called himself emperor and started to collect taxes. The Cannon Society emerged in western Honan in 1927 or 1928 with the slogans destroy the bandits and refuse to pay taxes. By and by they became the bandits and had to be disbanded by the Kuominchun. Members could freely kill their enemies and burn their houses. Eventually the leader, Chang Peng-chu was killed at Loyang, his subordinates burned alive and the remainder becoming bandits. The most notorious and perhaps long lasting society was the Red Spears who acted depending on the circumstances as a rural crop protection force or bandits. On September 23rd just outside of Penglai in Shantung a large force of Red Spears were destroyed by provincial troops. These Red Spears, largely a bandit group rather than a society had been terrorizing the areas burning 80 villages, looting and murdering even women with children who had escaped into the corn fields.

But calamities also led to banditry. In Kansu the famine provided conditions for the rise of a formidable "Mohammedan" bandit force of some 35,000 soldiers led by an 18 year old Major Ma Chung-yin. Ma intended to eradicate the provincial warlord force of Marshal Feng Yu-hsiang, the leader of the Kuominchun, who was having problems of his own with General Chiang Kai-shek. In reality, the Mohammedan bandit force leaned more towards plunder and burning than administration.[64] Elsewhere in Kansu another

[64] Howard, H.P. June 1st, 1929. Famine and "Mohammedan" Banditry Again Devastating Kansu. *China Weekly*

Moslem uprising was reported with a force of 20,000 associated with Szechwan warlord Wu Pei-fu (and other war lords) taking control of Southern Kansu except Tsinchow and Kongchang.[65] In a horrific squabble between Chinese and Moslems in Kansu nearly 10,000 Moslems were killed and many hundreds of Chinese. In May 1929 rebellious Moslems under a warlord attacked Chinese and Tibetans killing 80 Chinese in Old City, followed by 700 killed and another 100 drowned above Lupasi. In retaliation Chinese entered the Old City killing all Moslems unable to flee. When the Moslems returned in August they were separated with all men between ages 15 and 50, led outside the city gate and executed killing some 2,996 Moslems.[66]

Elsewhere the seemingly independent roving of armies was in display in Hunan where Gen. Lu Tih-ping was forced into exile at Nanking. Lu's provincial forces were spread throughout Hunan on bandit suppression when on February 28th a large military force dispatched by Wuhan Central Political Council entered the province on the grounds that Gen. Lu was tolerating bandits, sympathetic to communists, and abused financial power. Lu could not mobilize a defense and did not want to plunge the war-torn city of Changsha into further turmoil.[67] By March 1929, the situation in Shantung was deteriorating for farmers, particularly in the eastern part and around Ankiu and Tsingchow.

Review vol. 48: 17.

[65] Editorial. March 2nd, 1929. Moslems Start another Rebellion in Kansu. *China Weekly Review* vol. 48:10.

[66] Editorial. October 5th, 1929. Moslems Massacred in Kansu. *China Weekly Review* vol. 50: 199.

[67] Editorial. March 2nd, 1929. Hunan General Flees Under Pressure of Wu-Han Council. *China Weekly Review* vol. 48: 10.

The Japanese protection zone along the Kiaochow-Tsinan railroad had formed a barrier that the nationalist troops could not cross from the west and which warlord Gen. Chang Chung-chang's bandit soldiers roamed with impunity to the east with no interference from the Japanese. The bandit soldiers had split apart from the main force and set up small feudal locals over claimed territories in which many atrocities occurred. Farmers were robbed and when there was nothing to rob they were executed. Rape was rampant with bandit soldiers billeting in farm houses. Children were thrown to the roadside and women committed suicide rather than were raped. Desperate farmers rose up against the bandits but were no match and were killed in the hundreds and thousands with entire villages leveled.[68]

In October of 1929, 1,600 villages destroyed by fire, 20,000 people killed and 10,000 carried away for ransom by bandits starting about October 8th. The bandit force, 10,000 strong, rode with impunity since the villagers obeyed a central command to disband local militia. The bandits were eventually defeated by forces from Nanking and Kaifeng.[69]

1929 also saw a rise in communist activities, although the communists were treated more as a bandit force than a political threat. But by August of 1929 the communists had

[68] Chung, S.K. March 30th, 1929. Ten Million People in Shantung Doomed to Death. *China Weekly Review* vol. 48: 212.

[69] Editorial. October 12nd, 1929. Bandit Raids in Honan. *China Weekly Review* vol. 50: 235.

been very active in the southern provinces. In some instances the communists kidnapped people for ransom. For example on September 30th of 1929, 13 missionaries were captured from the Dominican Mission by Chu Teh and Mao Cheh-tung, eventually being released for $10,000 ransom.

Communist forces were reportedly active in western Fukien, northwest Kwangtung and parts of Kiangsi. Liencheng in western Fukien was taken by Chu Teh and Mao Cheh-tung on August 6th of 1929; the Suishui district of Kiangsi was taken by on August 4th with considerable loss of life and property. On September 23rd of 1929, the communists under Chu Teh recaptured Shanghang. The communist forces did not appear to have any stable hold for as one place was taken another had to be abandoned. However, in the abandoned areas the old land titles and contracts between landlords and peasants were destroyed. As the (liberal elements of) nationalist Kuomintang (KMT) pushed communist forces out, they did not necessarily restore the old system of land tenure but actually reconstructing the districts on a new and equitable basis, preventing the landlords from "regaining their old position of privilege and exploitation".[70] By March 1930 and through 1933 Communist activity was reported in Honan, Hupeh, Kiangsi, Fukien, and Kwangtung. It was not until March 1930 when editorials finally concluded that the

[70] Editorial. August 17th, 1929. Chinese Communist Armies Still Active in the South. *China Weekly Review* vol. 50: 530; Editorial. September 28th, 1929. Communists Recapture Shanghang. *China Weekly Review* vol. 50: 161; Editorial. October 5th, 1929. Communists Capture Missionaries. *China Weekly Review* vol. 50: 205.

communist forces were likely a permanent force. In many instance the communists would establish “soviets”. They would stamp out all vices when they took over a town including gambling and opium and sometimes even tobacco, but they are not very tolerant of the bourgeoisie resisting efforts. In April and March 1930, some 5,000 uncooperative land owners were executed. Other “oppressors of the people” were either exiled or shot. Religions and idols were banned, but reports from missionaries and other foreigners testified that looting was not rampant.[71]

The communist “Red Army” was made up of an amalgam of deserted nationalist soldiers, warlords and bandit gangs defeated by Red Army, and peasants. Recruiting peasants to the Red Army was an easy task. Corrupt magistrates and other officials as well as merciless militarists had gouged the farmers and peasants out of their solitary pig and mules, deprived them of what little stores of grains they held, and left them without any worries at all except the all-absorbing grim alternative of life or death. In contrast the communists protected farmers while growing their crop, eradicated local government, destroyed deeds, confiscated hoards of food and redistributed it all, asking only for a small share in return. “Could there be a more appealing argument to a farmer who has been forced to sell his wheel barrow to pay his tax?” From this cruel realities facing the Chinese farmer any change could only have been viewed as a gain, “for simple arithmetic

[71] Editorial. March 8th, 1930. Communist Menace Gaining in the South. *China Weekly Review* vol. 52: 75.

proves that no matter how much you subtract from zero, you get only zero. Having nothing left, they stood to lose nothing. Therein lay the strength of the communist appeal".[72]

The Red Army also worked alongside the so-called "Peasants Union" which was very aggressive at taking control of governments where Nanking's influence was weak. At times the peasant's union would lead combat raids ahead of the Red Army with hoes and clubs. The majority of union members were from the landless class or labor class that had nothing to lose with the structure of tenancy and sharecropping. Landowners, small and large may make a minimal living from renting out the land but sharecroppers must pay huge dividends in crop share to the landowners.[73]

In addition to bandits and warlords and communist insurgencies China in 1929 and 1930 was faced with the prospect of two civil wars against the Nanking Kuomintang government under Chiang Kai-shek. These were largely political conflicts in which the warring parties were largely supporting the Kuomintang but under the principles of KMT founder Sun Yat-sen rather than the republicanism of Chiang Kai-shek. In the southern provinces two forces arose and combined to challenge the government in Nanking. These were largely from the Wuhan faction in Hupeh province which held an alternative

[72] Hunter, E. January 31st, 1931. The Seriousness and Extent of Red Armies. *China Weekly Review* vol. 55: 322-325.

[73] Godwin, F. June 7th, 1930. Red Banditry in Hupeh; Disorganization without Communism *China Weekly Review* vol. 53: 24-25.

government to Beijing. The second civil war was instigated by the Shensi Christian general Marshal Feng Yu-hsiang who would ultimately pressure for yet another government in Peiping (Peking). Feng, once known as the Christian general, controlled a force of nearly 150,000 with the main force settles in Shensi. Feng was an officer during Qing (Manchu) dynasty (pre revolutionary 1911) but secretly joined, and was loyal to Sun Yat-sen and moved his forces against the Manchus. Between then and now his forces were republican loyalists with many excursions in battle and bandit control. It was argued that his forces were probably the best of all military forces in China, and a force to be reckoned with. Feng was solidly in support of Sun's three principles, but after Sun's death and the rise of the Northern Expedition forces towards a unified China he saw the revolutionary powers being more interested in control than the principles. Outright civil war in Shensi, Shansi and Honan was averted (at least in 1929) but the southern rebellion was more militaristic.

As mentioned, the governing and military authority of Chiang Kai-shek had always been tentative with armies comprised of seemingly loose alliances and even looser loyalty to the nationalist movement. In Hunan, three generals ousted an appointee of Chiang Kai-shek which upset the general balance of power. Shek with 150,000 troops from the First Route Army in the area started to send troops to Hunan. Gen. Li Chung-jen commander of the fourth route army and part of the Wuhan or Kiangsi faction also had available 120,000 troops. How troops behaved depended upon whether the various generals were allies or opponents within the KMT. The various generals still sought political and economic control over particular provinces. Gen. Li Chung-jen was attempting to bring Kiangsi under his control while Chiang Kai-shek was still trying to extend his control over Honan. It was clear that Nanking was losing patience with the Wuhan faction and that if the Wuhan generals did not submit to Nanking and the mandates of the Central Government another extended civil war would be inevitable. Indeed a mandate against the Kwangsi faction was issued later on March 26th with a manifesto on why civil military action was required issued by Chiang Kai-shek on March 27th stating that what was at play was more than a simple fight between Hunan and Hopeh but a challenge to the revolution itself.[74]

By April 1929, the situation along the Yangtze was very fluid with a showdown between the Nanking government forces under Chiang Kai-shek and the so-called Kwangsi forces that were loyal to the nationalist government but not loyal to Chiang as leader. The Kwangsi and Wuhan faction were being advanced upon in three directions by Chiang's forces from Nanking but no real fighting had taken place, although Wuhan defenders reportedly placed mines in the Yangtze River downstream of Hankow. However, in a surprise move on April 4th, a Kwangsi supporter Gen. Hsia Wei who

[74] Editorial by JBP. March 23rd, 1929. Is It to Be War or Peace on the Yangtze? *China Weekly Review* vol. 48: 154.

headed the 7th route army, switched sides to support Chiang and the 1st route army. Consequently Kwangsi troops refused to fight and turned towards Hunan to return to Kwangsi. The conflict in Wuhan was deemed over so much so that Chiang's orders to have Cantonese troops attack Kwangsi troops was refused on the grounds that the retreating Kwangsi troops were unlikely to engage in any further attacks. As Kwangsi troops fled to Hankow, Chiang's troops moved in causing many civilians to seek protection in the foreign concessions.[75] Ultimately the Kwangsi rebels and so called "Ironside" troops became a rebel force requiring a military response from Nanking.[76] These were by no means minor skirmishes. In two separate battles in Hunan between the Kwangsi or Ironside forces and nationalist troops, there were 21,000 casualties of which 5,000 were government troops.[77]

Militarism in China was not confined to banditry and civil war. For years prior to 1931 the Japanese had sought ways to increase its influence in Manchuria and China proper. On September 18th of 1931, a Japanese force of about 40,000 troops occupied the Chinese territories in south Manchuria (north Manchuria at the time being controlled by

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[75] Editorial. April 6th, 1929. Hankow in Hands of Gen. Chiang Kai-shek. *China Weekly Review* vol. 48: 226.

[76] Editorial. February 15th, 1930. Government Troops Rounding Up Rebel Bands in South China. *China Weekly Review* vol. 51: 410.

[77] Editorial. June 14th, 1930. Situation Deadlocked in Honan-Attention now Centered on Hunan and Shantung Fighting. *China Weekly Review* vol. 53: 49-52; Editorial. July 5th, 1930. Yen His-Shan's Policies and Kuomintang. *China Weekly Review* vol. 53: 169-172; Editorial. July 5th, 1930. Complete Collapse of Kwangsi and Ironsides Reported. *China Weekly Review* vol. 53: 193.

the Soviets).[78] The occupied areas included southern Fengtien province, including its capital Mukden which was also the seat of the Chinese political administration in Manchuria, and a considerable portion of Kirin province. Also occupied were key port cities of Newchang, Antung, and Changchun. Changchun was also the junction of the Japanese South Manchuria Railway and the Soviet China Eastern Railway. Some 30 million Chinese, one-third of all Chinese in Manchuria were then under Japanese occupation.

Within this territory laid Chinese railways that were adversely competing against Japanese and Soviet railways and also the Peiping-Mukden line which made up the main artery between Mukden and Peiping, south of the Great Wall to southern Chinese markets. In essence Japan had control over all ports, all rail and thus the shipments of all goods into and out of Manchuria. The Japanese also took control of all telegraph lines and radio stations, so that all communication into and out of Manchuria was under the control of the Japanese. In fact the only news about the occupation came from Japanese sources and even foreign consular offices had to send communiques via Japanese lines and then retransmitted. Business interests in Shanghai and other business centers south of the Great Wall had no means of communication with interests in Manchuria.

What instigated the occupation is an interesting story. The Japanese accused the

[78] Editorial. September 26th, 1931. Japanese Military Occupation of South Manchuria. *China Weekly Review* vol. 58: 127-132.

Chinese of blowing up a bridge on the south Manchuria Railway at Liutaiokuo station north of Mukden. What ensued was a clash between Japanese railway guards and Chinese troops. This was reported at 10:30 pm. By 6:30 am, the walled city of Mukden was occupied and its Chinese forces and police disarmed. As daylight broke on the morning of Saturday, September 19th, Japanese troops within Manchuria and from Korea were mobilized and on the move. In addition, Japanese citizens in Mukden had been pre-warned. Later it will be discovered that the bridge was actually blown by Japanese militarists looking for an excuse for occupation; the connivance worked. By the 20th riots had broken out in Kyutsekai and Lungchingson near the Korean borders putting Japanese in grave danger. By this action the militarists were able to convince Tokyo to expand military activities. Thus, if Japan were to increase its military presence in Manchuria it was believed at the time that the cause would have been the murder of two Japanese militarists by Chinese or bandit forces. The two soldiers were travelling on civilian passports in plain-clothes in Inner-Mongolia and might have been declared spies on their discovery. Nonetheless the so-called "Nakamura Affair" was to be settled amicably at the political level between Tokyo and China Foreign Office and as late as September 17th was not a cause for military action. Indeed, by September 19th reports were made that the murder of Captain Nakamura was by Chinese regular forces and that several Chinese officers were to be taken to Mukden for trial and execution. It was a report out of Tokyo that first suggested the bombing was a consequence of a clique of young “hothead” Japanese militarists who were enraged by the murders and political solution, seeking a military retaliation instead.

In actuality the Japanese often sought reasons to expand military presence in Manchuria. Nakamura, travelling as a PhD researcher was probably a spy and justly executed according to the law at that time.[79] The Chinese seeing that the affair could lead to increased militarism and mobilization evaluated the political calculus and concluded that the lives of a few officers were a small price to avoid an all-out military conflict. For those Japanese seeking this conflict, a new excuse was necessary. Also the timing was impeccable. With the Nanking government faced with military activism in Canton and by communists elsewhere, combined with the severity of the Yangtze and Yellow River Valley flooding, there was not much China could do immediately except to protest. On the Cantonese Chiang Kai-shek urged a halt to actions to deal with the Japanese occupation, but to the Communists Chiang Kai-shek would make no peaceful compromise.

The annexation of Manchuria was followed shortly thereafter by the Shanghai conflict.[80] The so called “Shanghai Incident” of January 29th in 1932 refers to the

[79] This does not imply that the author of this thesis condones executions of any kind.
[80] Editorial. February 13rd, 1932. League Committee’s Report on Shanghai. *China Weekly Review* vol. 60: 335-336; Editorial. January 23rd, 1932. The Ban on Japanese Goods in Honan. *China Weekly Review* vol. 60: 258; Editorial. March 12nd, 1932. The Chinese-Japanese Battle-Front at Shanghai and Geneva. *China Weekly Review* vol. 60:

military clash between Japanese marines and China's 19th Route Army. The incident itself was the culmination of a great many stressors and a general distrust of the Japanese' intension to occupy Shanghai as it was presently doing in Manchuria.

The Manchurian occupation and the massacre of Chinese civilians in Korea led to wide spread boycotts of Japanese goods and services starting around July of 1931. The boycotts were enforced by such organizations created for the purpose such as the Ant-Chinese Boycott Association which enforced the boycott by picketing shops selling Chinese goods, harassing Chinese working for Japanese employers, and intimidating Chinese buying any sort of Japanese goods or services. In some provinces and political jurisdictions legal authority was given to remove Japanese goods from stores and imprison sellers or buyers who violated the pact.

Protests by students denouncing Japan and calling for war with Japan over Manchuria led to increasing hostilities between Chinese and Japanese. These protests also made derogatory remarks about the Japanese Emperor who was believed to be a son of Heaven. On January 18th of 1932, five Japanese including several monks were attacked by a Chinese mob outside the San Yeh towel factory in the Shanghai district of Chaphei. Two of the Japanese were wounded with one of them, a monk, dying shortly thereafter.

41, 42-63; Editorial. March 12nd, 1932. In the Wake of Chinese Conquest. *China Weekly Review* vol. 60: 45; Editorial. May 7th, 1932. Proposed Sino-Japanese Shanghai Agreement is Innocuous Document. *China Weekly Review* vol. 60: 317-318.

On January 20th a mob of 50 Japanese from the Japanese Youth Protection Society retaliated, and with knives, daggers and clubs on hand burned the towel factory and clashed with Chinese municipal police, wounding two and killing one. Three Japanese were shot by police, killing one.

That same day Japanese residents sent a message to Tokyo requesting the Japanese government to send warships and troops to completely suppress the anti-Japanese movement. These same Japanese clashed with police of the International Settlement wounding a British soldier. In the afternoon of the 10th the Japanese Consul-General presented an ultimatum to the Mayor of Shanghai concerning the events of the 19th including 1) a formal apology by the mayor, 2) the immediate arrest of assailants, 3) payment of solatium and hospital bills, 4) adequate control of anti-Japanese movements and 5) the immediate dissolution of all anti-Japanese organizations involved in fostering hostile feelings, riots and agitation.

On January 21st the mayor notified the Japanese consul that he could acquiesce to the first 3 points but the latter two points could prove difficult. Later on the 21st the admiral of the Japanese fleet announced that it the mayor could not provide a satisfactory response then the admiral was determined to take appropriate steps to protect the rights and interest of the Empire of Japan,[81] indicating that the text of a telegram from Tokyo

[81] Editorial. January 30th, 1932. Once More, Japan, Beware!-Hands Off Shanghai! *China Weekly Review* vol.

implied that the admiral's ultimatum was explicitly referring to the use of the armed forces of the Japanese navy in order to dissolve the Anti-Japanese Society and give protection to Japanese residents. The Chinese actually closed the Anti-Japanese society but the Japanese applied force nonetheless. This article published in print form on January 30th would not have included the January 29th incident in its text and thus provides a prescient view of how the Chinese viewed Japanese aggression and the belief that Japan one way or another was going to use the towel factory incident to flex its muscles in Shanghai. The mayor for his part was working with the municipal council to avoid any possible conflict and succeeded in closing down the Anti-Japanese Boycott Association. Nonetheless, by January 24th Japanese reinforcements arrived off Shanghai while Chinese troop reinforcements moved into Chapei.

The Japanese admiralty and the consul general's ultimatum expired on 6pm of January 28th and before expiry the mayor delivered a note to the consul-general acceding to the demands in their entirety and this was deemed satisfactory by the consul general. While the ultimatum was playing out the International Settlement Defense Committee had issued a state of emergency, but did not lift the state of emergency for fear that the Chinese could not enforce its promises or that the Chinese citizenry would riot at the humiliation of succumbing to the ultimatum. The state of emergency established certain

60:267.

defense rights within the boundaries of the international settlement but nothing was said about areas outside the international settlement including areas of western Shanghai that included Hongkew park where many Japanese lived and the Woosung railway station. Although this area was outside the international settlement it was not unusual for Japanese marines to have security posts in the region. Around 11 pm on January 28th the admiral notified the defense council that it was going to move a detachment of marines into the Chapei region and that Chinese troops should remove themselves to the western side of the Woosung railway station.

Chinese troops refused to move as demanded and fighting broke out between Chinese regular troops and Japanese marines. The Chinese held their ground at the Woosung rail station and was able to use an armoured train against the Japanese. The Japanese in turn bombed the rail station and the train and then proceeded to bomb the surrounding buildings with incendiary bombs to remove sniper positions.

The provincial Kuomintang and the Anti-Japanese association in Honan announced a series of laws regarding the boycott including fines of $50-500 for minor offences and execution for serious offences. Twenty large stores selling primarily goods from Japan have closed their doors.

By early March 1932 the Japanese had not only advanced through Shanghai but had extended their reach to about 45km from Shanghai, deep into the farming countryside. By then the battle had left Shanghai and diminished to a number of skirmishes between the two forces, while the League of Nations attempted to address the issues from Geneva, with the Chinese demanding that all Japanese troops remove to their warships. In a surreal image the battlefield outside of Shanghai and the Chapei district is a clutter of images of farmers tilling the fields after the vast armies had maneuvered over the area, to villages in which peasants and villagers worked at the end of a Japanese bayonet doing odd jobs while Japanese civilians burned outlying buildings not destroyed by Japanese bombs. Farmers were killed on mass by both bombs and bayonets in this area.

By May 7th in 1932, a Sino-Japanese truce was signed ending hostilities between Japanese and Chinese with Chinese troops remaining in the positions current at that time and Japanese troops returning to the international settlement in Shanghai.

Despite Japanese aggression, internal conflict was not arrested in the remainder of 1932 and into 1933. Communist suppression in the south and Japanese aggression in the north laid waste to many farms and disrupted the agricultural economy in many ways as has been discussed above. The main focus is: Militarily was in communist suppression in the southern provinces, although civil wars in Shantung and Szechwan were also reported. Japanese hostilities in Manchuria extended to Jehol and the Great Wall but by May 31st in 1933 an armistice was signed holding the Japanese to the north of the Great Wall.

3.3 Geopolitics and Agricultural Conditions

What is largely unobserved in Buck's data is the provincial or regional geopolitics. Lease arrangements, farm tenancy, taxation and so on are all factors with credible impact on agricultural productivity. For the most part these are systemic and cannot easily be captured by factor-specific variables. Rather these are captured regionally by provincial instruments and more broadly by agricultural areas. These impacts were discussed by journalist Harry Paxton Howard[82]…"*The peasantry is the backbone of the Chinese people. The cultivators of the soil are the greatest productive elements of the country. And it is they who are the worst sufferers from war when it invades their districts. They have everything gain from peace— if it is a peace based upon enlightened policy and not merely on bayonets…A policy devoted to the interests of the peasantry is not mere altruism. Every thought of altruism may be cast to the winds (as it already appears to have been by many leaders unfortunately), and the stubborn and undeniable fact remains that a policy in the interest of the cultivators is the soundest and most intelligent policy that can be pursued. That free labor is far more productive than involuntary is a clearly established economic fact. A class of cultivars feeling themselves the master of their own soil and free to enjoy the fruits of their labor is a sound basis for political and social*

[82] Howard H. P. April 20th, 1929. The Problem of China's Unification. *China Weekly Review* vol. 48: 324-328.

stability. A class driven to desperation by rent, taxes and usury is a basis for an impoverished economy and perpetual discontent…A peasant policy is not a simple thing to be worked out particularly in the widely varying conditions throughout China. But if the essential aim is clarified the details become less complex. This aim must be devoted to the welfare of the actual cultivators of the soil. Whether owners, tenants or farm laborers, they must be dealt with as cultivators— if they are. The cultivator feeds everyone else, whatever may be the form of land tenure…It is probably fair to state that most farmers of China would be quite satisfied to be let alone. If the question was put to them as to what the government could do for them, the first thought of most of them would probably be (though it would perhaps remain unspoken), 'Ah, please get off our backs!'…If the agrarian policy be taken as basic, a policy may be founded upon their fundamental necessities. The primary need is freedom from pillage— this making them a basic factor for peace. Beyond this there is required a policy which will free cultivation from taxation. Taxes should rest upon non-productive ownership rather than upon productive cultivation. The ratio should be according to the value of the land, not according to the value of its product. The proposed new land law is the most important move yet made by the Nanking Government with regard to internal policy— but it is still only a proposal…As regards rent, the tenant farmers in some districts— even here in Kiangsi— have solved the problem themselves by simply refusing to pay it and terrorizing the collectors into *keeping away from their villages. In some places the government has not interfered. The Nanking Government has far more important things to do than protect the property of absentee landlords against the cultivators who feed the nation. Nevertheless, there are many districts where the tenants have so taken affairs into their own hands. From the governmental viewpoint, a practicable policy would be to take up the rental value of land from the landlord and apply it to public uses. The proposed land law appears to aim at this…With the elimination of crushing rents and taxes on cultivators, comes the possibility of a positive program. Such a program has already been projected by the Kuomintang, but its realization still belongs for the most part to the future. The most essential features would appear to be (1) cheap credit, best of all in the form of co-operative credit unions; (a start on this has already been made.) (2) Cheaper goods, which necessitates the elimination of the various business and transit taxes which weigh so heavily upon commerce here, and could be furthermore assured by the formation of co-operative consumers' societies; (3) better prices for products, which could best be gained by cooperative marketing; (4) improved communications, which will make exchange easier and facilitate the production of surplus (but only if the cultivator can see himself receiving the benefit of this surplus); (5) better seeds, new crops, other technical improvements…The above remarks are applicable to most of the country. Some districts, however, are faced by even more urgent needs— flood control and irrigation. At the same* *time, it must be remembered that the ultimate cause of famine is the lack of any margin in normal years. Most of the victims of famine in Shantung today have been sucked dry and rendered destitute by merciless taxation year after year. If improved conditions permit the cultivators to accumulate a surplus in good years, and some check is put on steady growth of population, the basic causes of famine will be removed, though floods will still remain a danger until some of the rivers (particularly the Huang and Hwei) are brought under control, and droughts will be a nuisance until communications and industrial and commercial development make it possible for the population of affected districts to turn to other occupations in bad years*".

In addition to the absence of economic infrastructure much of China was largely separated by distance and geography that made trade amongst regions complicated if not prohibitively costly. For example by one account it took 22 days to travel from Shanghai to Chunking in Szechwan, a distance of about 1,000 miles as four days up the Yangtze River to Hankow, another four to Inchang and four more to Chungking for a total of 12 days and then on to Chengtu overland by chair in 10 days. The road from Chungking to Chengtu is actually a stoned path about three feet wide over most of the distance, laid out in stone slabs about 5 inches thick, one foot wide and three feet long. Transport is done by professional coolies who would organize gangs to carry man and luggage. Hilly and mountainous terrain made railroad construction difficult and expensive which added to the economic isolation of the region but in 1929 some headway was being made in the construction of roads for a motor way, but the roads built to grade, village by village, were unpaved and almost impassable in rainy weather.[83]

Furthermore the actions of provincial governors, mostly former warlords or militarists of one sort of another acted with near impunity in terms of allocating funds transferred to the provinces from the central government. For example, Gen. Feng Yu-hsiang, the warlord premier of Shensi had on Nov 28th of 1928 made an appeal on behalf of Shensi, Honan and Kansu for $100 million to cover labor relief and direct aid including infrastructure, well sinking and irrigation. Brigandage, the formation of bandit groups was on the rise as a result of the famine. Nanking authorized $1.25 million (1.25%) in December 1929 to be split Kiangsu, Kwangtung, Chekiang, Anhwei, Hupeh, Hunan, Hopeh, Szechwan, Fukien and three eastern provinces but it was not clear whether these were general allocations or specific to reported famines. Ultimately Feng had received nearly $800 million from Nanking for famine relief but used the money to buy airplanes and armaments. With a very awkward logic, apparently Feng saw no point in sending money into the countryside and then going in and removing money in taxes, even though he did remit taxes. On the other hand the farmers were in no position to pay taxes in any

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[83] Nyhus, P. August 17th, 1929. Some agricultural and Economic Notes on a Trip to Szechaun Province. *China Weekly Review* vol. 48: 516-518, 521.

case, and those that did came nowhere near close enough to support famine relief.[84]

As previously discussed the communists used the problem of excessive taxation to win over peasants in the establishment of soviets and for military recruitment. But by 1933 other aspects of progress were being made, largely in response to the flooding and observed conditions in agriculture by the University of Nanking.[85] A series of credit relief efforts were organized by the School of Agriculture at the University of Nanking (D.Y. Lin). Included in this relief is the establishment of agricultural banks and in fact a central agricultural bank was to be considered.

The Nanking managed relief had restored nearly 1 million mu of land using refugee labor (presumably with wheat payment) but in order to get farmers back on the fields an amortized loan system was established. Under this scheme farmers could borrow seed grain directly or money to purchase seed grain, fertilizer or implements for the planting of winter crops. These loans were to be administered by Ningshu Agricultural Relief Association "*to afford a permanent agency for promoting the agricultural and economic welfare of the rural population of this (Ningshu) region*". One of the first projects was to colonize some uncultivated land in the Chuyung hsien along the Ching Hwei River which was badly damaged during the 1931 floods. About 3,500 mu was set aside to support

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[84] Howard, H. P. June 1st, 1929. Famine and "Mohammedan" Banditry Again Devastating Kansu. *China Weekly Review* vol. 48: 17.

[85] Editorial. February 4th, 1933. Some Practical Applications of Farm Relief. *China Weekly Review* vol. 63: 407-408.

some 150 farm families. Colonists would be provided a loan to cover the costs of seed and other inputs, food, and material for a shelter for the first year and this would then be repaid within a 3 to 5 year period.

In addition short term loans and mortgages were issued to rice farmers facing the low rice prices in spring of 1932. Farmers would have had to sell twice as much of their stores than normal, and this provided an opportunity to bridge the price gap with a loan. To guarantee the loan the farmers were required to deposit their cheap rice as a mortgage in one of 101 depots scattered across the area. It was reported that some farmers were walking as much as 30 miles with rice on their shoulders to get the loans. Most of the 3,014 families assisted by the commodity loans held less than 30 mu of land. Larger farmers who had resources were not eligible. At most a farmer could deposit 1,500 catties (1 cattie = 500 g or about l bs) and could receive up to $30 in credit of ($0.02/cattie or $2/tan with 1 tan = 100 cattie). Interest was set at 1% and loan terms were from 4 to 6 months. When the loan was paid the farmer would remove the rice from the depot. An average loan was about $15. Farmers would be issued a Deposit Receipt which itemized the transaction and its terms and this was the only record of the transaction. And the deposit receipt was transferable and could be sold to a third party and the rice released to the third party so long as the loan was repaid with interest. If the loan was not repaid then the rice would be auctioned.

In addition Nanking University reorganized cooperatives in the district to encourage wheat production using wheat cultivar #26 which was tested by Nanking University to increase yields by 10-15%. #26 seed was also loaned to farmers on the condition that they would follow certain cultivation practices in line with the cooperatives.

Dean Lin stated "*These cooperative societies are, in our opinion, most important, and we hope to make them a permanent feature of our work in the Ningshu district. Think of the hundreds of things that we could do for soil and crop improvement, animal breeding, forestry, and for general rural betterment through such societies. The solution of China's agricultural problem in my opinion lies in having such co-operative societies properly organized and properly directed.*"

3.4 Summary

This chapter reviewed the history of China over the period 1929 to 1933. The main events were the 1929 drought and famine, the 1931 floods, communist insurgency and warfare with the KMT, banditry and civil war. This environment is believed critical to the understanding of Buck's data and to truly appreciate the economic determinants of agricultural productivity during that time period. The economic conditions as described in Chapter 2 are combined with the historical developments as context provided in this chapter to construct the econometric model which is described in the next chapter.

Chapter 4: DATA AND METHOD

4.1 Data Source and Missing Values

This thesis uses data from two sources. As discussed in Chapter 3 the *China Weekly Review* was used to identify the timing and locations of major calamities and conflicts. The primary data for agricultural productivity, inputs to the production process, village, provincial and agricultural area definitions are compiled from the third volume of Buck's series of academic magnum opus, *Land Utilization in China*—Statistics. This volume summarizes at the village level individual household surveys from 16,786 farms in 168 localities, and 38,256 farm families, in 22 provinces in China, from the year 1929 to 1933. It was first published by the University of Nanking in 1937 as a report in the International Research Series of the Institute of Pacific Relations, and issued under the auspices of the National Economic Council and the Central Bank of China. Exclusive distributors were all senior as the ratification for the professional and accuracy of Buck's investigation: for China and the Far East was the Commercial Press, LTD., Shanghai; for the United States, the University of Chicago Press; for the Great Britain and the Continent, the Oxford University Press. There are 12 chapters, including Climate, the Land, Nutrition, Livestock and Fertility Maintenance, Prices and Taxation, Crops, Size of Farm Business, Farm Labor, Marketing, the Standard of living, Population, and Sources of Information.

Localities in each table are arranged under the frame of the eight agricultural areas. *Land Utilization in China* was Buck's analysis and interpretation of this data set. This thesis utilizes the same database, but for a thoroughly novel research of agricultural productivity. Process to digitize the statistical volume took two semesters.[86]

Out of our control are a large amount of missing values chiefly stemming from two circumstances: Name of places were omitted to save space in tables where information did not apply or exist; every of 58 localities was divided into more than two parts, and some even have 5 parts. Different tables cover various localities and subparts. For instance, Nancheng occurs as Nancheng (1) in table A, as Nancheng (1) and Nancheng (2) in table B, as Nancheng (1)-(5) in table C, as Nancheng in table D, and disappears in table E. Thus for most tables taken into account, Nancheng (2)-(5) are presented as missing values. It must be kept in mind that these data were collected and summarized during a very difficult period in China's history and without the foresight of database structures, computer programs, econometric methods and tools, or economic theories that had not been developed at that time. Our approach is tested by the rudimentary (yet still sophisticated) collection and computational methods available at the time, but with the advantage of modern econometric and statistical tools.

[86] See Appendix Part II.

4.2 Dependent Variables

Our basic approach was to discern amongst the various variables available that best capture the key influences on agricultural productivity. This was discussed in Chapter 2 to some extent but here the data is described in detail. Our data set was constructed by hand-translating Buck's data tables into a digital format. These input-output factors were in accordance with the literature review and in line with modern production theory, to decipher the agricultural land production markup and slump from the year 1929 to 1933. There are three variables chosen as dependent variables: "*Average_yield*", "*Ratio_avg_to_normal*", and "*Ratio_avg_to_best*". Page 208 displays average yield, normal yield, and best yield as crop index[87] based on most frequent yields as 100 for each locality. The change of index for different localities as relative change cannot be compared directly with each other because their base numbers are all 100 and each 100 equals to a different total amount of yield. Literally "*Average_yield*" denotes the average yield of all farms surveyed in a particular locality. "*Ratio_avg_to_normal*" denotes the ratio of average yield to normal yield, and multiplied by 100 to magnify the alteration. "*Ratio_avg_to_best*" denotes the ratio of average yield to best yield, and multiplied by 100 to truncate the decimal digits. Both normal yield and best yield are fixed historical numbers. Hence

[87] Crop index refers to the most frequent yield per hectare of the important crops measured in quintals for crops found on 20 percent or more of the farms.

the ratios provide a contrast between average yield and normal or best yield. The latter two ratios convey the marginal effects of the conditions at the time of the survey. In essence our econometric approach using these dependent variables measures the degree by which the production variables, calamities, conflicts, location, and time frame impacted agricultural productivity. This determination is the principle objective of this thesis as outlined in Chapter 1.

4.3 Candidate Control Variables

There are 12 candidate control variables or production variables in the regression (listed in rank of significance according to results of the first unrestricted model[88]): "Pct_crop_area_irri", "Num_parcels_per_farm", "Total_mwd_pfn_in_marketing", "Pct_cult_landarea", "All_farms_ind_doublecropping", "Avg_dist_of_ farthest_parcels_km", "All_farm_fertilizer", "Sold_immediately_after_harvest", "All_farms_la", "Size_crop_hectare_area_mean", "All_farms_manequiv_per_farm", and "Total_l_cost_yl".

"*Pct_crop_area_irri*", on page 214, denotes the percent of crop area irrigated for all crops in each season, including winter crops, spring planted crops, summer crops planted after winter crops, summer crops planted after spring crops, fall crops planted after spring summer crops, and perennial crops. Another parallel variable, "Pct_all_land_irrigated",

[88] See Appendix Part I.

on page 53, refers to percent of all land irrigated but does not involve the crop area. Therefore, as the analogous description of irrigation, it is not identical to “Pct_crop_area _irri”. And only one of the apparently similar variables should be kept to avoid collinearity.

“*Num_parcels_per_farm*”, on page 47, denotes the number of parcels per farm. Hold the average size of farm and land quality constant, the more parcels a farm comprises, the greater agricultural production that farmland may yield. Since variables of farm size and land quality are given as below, number of parcels per farm makes sense. “Number of fields per farm”, on page 47, is ruled out because all numbers in this column are greater than or equal to the numbers for number of parcels per farm. Some area of uncultivated land, such as uneven hill land, barren land, and oddment land, was mixed in when the larger unit of land—field, was taken to replace the smaller unit—parcel. In that sense, number of parcels per farm stands for the more arable land with better quality thus might provide higher yield than number of fields does.

“*Total_mwd_pfn_in_marketing*”, on page 343, denotes total man work days per farm need in marketing products. This variable comprehensively and essentially declares the total man labor required as transaction cost of marketing.

“*Pct_cult_landarea*”, on page 38-39, denotes the percent of cultivated land area to land area. This variable is to substitute the percent of land in each class of productivity (usually by tax classification) because the weight of each of the six classes is unwarranted to decide for constructing a conclusive index of productivity. Moreover as mentioned in literature review, tax class was determined primarily according to political boundary without special consideration of land quality for each locality. And large amount of missing values for land productivity classification would result in much more loss for degree of freedom compared with percent of cultivated land area.

"*All_farms_ind_doublecropping*", one page 296, denotes the double cropping index for all farms. Double or even triple cropping on nearly two-thirds of the cultivated land was a way by which Chinese farmers had adjusted production to the density of population. Ceteris paribus, the more cropping times a farm experiences, the better yield would be.

"*Avg_dist_of_farthest_parcels_km*", on page 47, denotes the average distance of farthest parcels in kilometers, implying the transaction cost within each farm. On one hand, longer average distance of farthest parcels indicates the more time and energy wasted on commuting, which increases the likelihood of missing opportune nurturing for some parcels. On the other hand, long average distance of farthest parcels signifies fragmentation, which hinders the scale economy of cropping but accomplishes risk management.

"*All_farm_fertilizer*", on page 137, denotes amount of fertility produced on the farm for all farms. Animal manure and night soil per crop hectare in kilograms is offered.

Since industrial production of fertilizer was unrealized in that era, this variable can be deemed as the direct data for fertility indicator.

"*Sold_immediately_after_harvest*", on page 343, denotes percent of farm products sold immediately after harvest. This indirectly introduces percent of farm products that did not need inventory, which abates the transaction cost of dehydration, and man labor input for storage risk management against insects, rodents, dampness, fire and theft, as mentioned in literature review. Another case revealed could be the transportation convenience and capacity. Crops in some localities that should be immediately sold after harvest had to be stored for at least a while waiting to be integrated together for collective transportation due to the limited amount of wheelbarrows or carts. Or for farmers could have profited from storing crops until the price went up after abundance faded away for those sold immediately after harvest, extraordinary extortions of senseless heavy taxes and perilous venture might compel farmers to sell crops as soon as it was harvested.

"*All_farms_la*", on page 135, denotes labor animal units per man-equivalent for all farms. Among all the candidates describing labor of animal, this is sole relevant since total amount of animal labor invested does not exist. A merit of this variable is labor animal units per man-equivalent displays the diverse marginal rate of substitution between animal labor and man labor in line with local species of animal input as animal labor. For instance, the cattle were prevalent for plowing in the north— Wheat Region while the buffalo were widespread in the south— Rice Region.

"*Size_crop_hectare_area_mean*", on page 286, denotes size of farm as measured by mean of crop hectare area. As stated in literature review, farm size did not determine yields. In order to support family, small farms could not hold as much unproductive land (such as low, alkali, or sandy land) as large farms did. Hence yields on small farms in several localities were greater than on large farms but the difference was very slight. The most economical unit of farm was usually the large and family sized one. But optimized farm size would vary in terms of family size, types of crops grown, and soil productivity.

"*All_farms_manequiv_per_farm*", on page 297, denotes man-equivalent per farm for all farms grouped by size of farm. "Man-equivalent measures the number of workers according to the equivalent of one person doing the work for a period of twelve months".[89] It gauges how the average amount of human labor input per unit area varies among different localities. The larger the number is, the better the production would be, or the greater difficulty could be due to the time spent on risk management, such as regular irrigation and the rescue of crops for calamities. Possible substitution variable is "Pct_farm_allwork", on page 305, referring to percent that farm work was of all work (farm and subsidiary). Reason to abandon this replacer is that it does not incarnate the amount of man labor.

[89] Buck, J.L. 1937. *Land Utilization in China*— Statistics: Preface.

“Total_l_cost_yl”, on page 328-329, denotes total labor cost of year labor as farm wages in silver yuan. Day and monthly labor (during growing season) cost are excluded in that the quantity of days and months farmers work varies in different localities, and all other data of cost is presented annually. For instance, farmers in south China work longer than farmers in the north because cropping systems alter due to the discriminating length of growing season. Though not all workers are hired as year labor, to drop day and monthly labor cost is imperative since the proportion of the three types of employment is not available.

4.4 Dummy Variables

Dummy variables are treated as instrumental variables[90] for incidents, consisting of mainly three parts: *location on provincial level* recorded with its agricultural area and region, *time span for investigation,* and *calamities and conflicts*. These three groups of dummy variables are designed to track the impact of specific events by clarifying the locality within which province, agricultural area and region, the point of time or duration for which type of calamity or conflict that occurred to reduce residual.

Three groups of dummy variables cannot show up together in a regression because

[90] To be instrumental variable, it should satisfy four conditions: it is uncorrelated with stochastic error term; it is uncorrelated with all other independent variables; it is highly correlated with the independent variables it substitutes for; it is uncorrelated with other instrumental variables. In sum, the instrumental variable is exogenous and relevant for explaining variation in independent variables. Wooldridge J. M. 2009. *Introductory Econometrics—A Modern Approach* Chapter 15: 508.

once the location and time is ascertained, the calamities and conflicts occurred within the province that investigated locality pertained to is consequently definite. Error might exist for that the major calamity or conflict happened on provincial level may not disturb the surveyed village. The catastrophe variables including major drought, major flood, aftermath of major drought or flood, civil war, the rise of communism and banditry, the military action against communists, and Japanese invasions and annexations of Manchuria thereby can be used to substitute provinces, time spans or both groups.

Table 4.1 Definition of Variables

Variable	Name	Page	Meaning
Dependent Variable	Average_yield	208	average yield as crop index based on most frequent yields as 100
	Ratio_avg_to_ normal	208	ratio of average yield to normal yield×100
	Ratio_avg_to_best	208	ratio of average yield to best yield×100
Independent Variables (listed according to significance ranking)	Pct_crop_area_irri	214	percent of crop area irrigated for all crops in each season
	Num_parcels_per _farm	47	number of parcels per farm
	Total_mwd_pfn_in_ marketing	343	total man work days per farm need in marketing products
	Pct_cult_landarea	38- 39	percent of cultivated land area to land area
	All_farms_ind_ doublecropping	296	double cropping index for all farms
	Avg_dist_of_ farthest_parcels_km	47	average distance of farthest parcels in kilometers
	All_farm_fertilizer	137	amount of fertility produced on the farm for all farms
	Sold_immediately	343	percent of farm products sold

Variable	Name	Page	Meaning
	_after_harvest		immediately after harvest
	All_farms_la	135	labor animal units per man-equivalent for all farms
	Size_crop_hectare _area_mean	286	size of farm as measured by mean of crop hectare area
	All_farms_ manequiv_per_farm	297	man-equivalent per farm for all farms grouped by size of farm
	Total_l_cost_yl	328-329	total labor cost of year labor as farm wages in silver yuan
Dummy Variables (three groups)	location on provincial level	From all tables	in which province, agricultural area and agricultural region the locality was
	time span for investigation	464-472	during which period, between which months in which year the investigation or survey took place
	calamities and conflicts	From CWR	which type of catastrophe happened

Table4.2 Description of Variables Except for the Dummy

Variable	Obs.	Mean	Std. Dev.	Min	Max
Average_yield	211	98.93	15.65	30.3	160.9
Ratio_avg_to_normal	201	78.94	13.74	21.9	133.6
Ratio_avg_to_best	211	69.60	12.95	15.9	112.1
Pct_crop_area_irri	208	48.43	38.54	0	100
Num_parcels_per_farm	217	5.34	4.60	1.1	59
Total_mwd_pfn_in_marketing	174	24.93	27.20	0.5	179
Pct_cult_landarea	213	54.57	34.45	0.5	100
All_farms_ind_doublecropping	213	149.54	38.50	100	266
Avg_dist_of_farthest_parcels_km	217	1.09	0.64	0.2	3.4
All_farm_fertilizer	197	7916.69	7449.55	981	71607
Sold_immediately_after_harvest	210	53.59	24.09	0	100
All_farms_la	199	0.53	0.31	0	1.84
Size_crop_hectare_area_mean	217	1.97	1.27	0.36	11.06
All_farms_manequiv_per_farm	201	1.91	0.55	0.7	3.9
Total_l_cost_yl	210	83.10	27.61	4.11	160

4.5 Method

In this thesis regression with robust standard errors (to correct for heteroskedasticity) and analysis of covariance are applied to study the consequences of specific events of calamities and conflicts on agricultural productivity. Because of missing observations several challenges are faced with respect to robustness. First, when all of the candidate control variables were put into the regression, only 121 villages were included. This model was most informative to understand the production relationships between the 12 candidate control variables and productivity, but the low number of villages concerned us, especially when it came to examining calamities and conflict which are best observed over a much broader space representation. To increase the geographic degrees of freedom, then a number of step-wise regressions were run to determine whether there is a mix of control variables that would not reduce R^2 by too large an amount meanwhile adding the regional diversity. This resulted in using only three control variables with an increase in villages to 151. Finally models that excluded all of the control variables were processed, essentially spreading their effects to the intercept and regional or temporal dummy variables and this increased the number of villages to 201, but this too came at a cost of reduced R^2. Due to the inverse relationship between spatial degree of freedom and R^2, the full suite of regressions was provided in the results.

Because of the large number of dummy variables, Analysis of Covariance was employed with different combinations of dummy variable groups including Agricultural Areas, Provinces, and Time Spans for three dependent variables. Furthermore, restricted regressions with only dummy variables are posted, including Time Span and Provinces, Time Span and Agricultural Areas, Provinces and Catastrophes, for two ratio dependent variables separately. Analysis of Covariance is implemented to conclude whether Catastrophes affect average yield change. The effect of each major calamity or conflict can thus be measured and compared at the provincial level. Five representative provinces on behalf of different relative yield change level are screened out to be targets for genetic analysis of agricultural productivity alteration.

Production theory is the footstone to examine the effects of input factors, such as irrigation, land quality, transaction cost, labor wage, fertilization, size of farm[91], and cropping system. The causal influence of contemporaneous events in such an analysis is methodologically new and an innovation of this thesis. As previously discussed, and presented in Chapter 3, this research summarized major calamities and conflicts from volumes of documents and files for China Weekly Review in 1929-1933 and recorded every momentous event in the form of time and its duration, location or the scope, people involved, causes, process and the consequences. Those precious historical materials fill

[91] Population is missing here since population is positively correlated with size of farm by literature review. And population itself is not an input factor. In production theory, the input factor expressing the meaning of population and its density is, man labor—man-equivalent in this thesis which is already set as a candidate control variable: "All_farms_manequiv_per_farm".

up the void behind three groups of dummy variables to reinstate the whole dynamic story of agricultural productivity and even rural life in China at that time. Thus readers can touch the Pearl S. Buck[92]'s world from another perspective of economic and anthropologic analysis.

In conclusion, modern econometric techniques using historical data and events are used in this study. The results from the econometric approach outlined in this chapter are presented in detail in the next chapter.

[92] Author of *The Good Earth*. She was the first American woman laureated Nobel Prize for Literature. Her first husband was John Lossing Buck. They met each other during the field work for *Chinese Farm Economy*.

Chapter 5: MODEL DEVELOPMENT AND ECONOMETRIC RESULTS

This chapter provides the econometric results as described in Chapter 4. Because of the number of regressions run (using STATA), a brief outline of the chapter is provided here. The relationships are examined between the 12 production control variables against each of the 3 dependent variables (average yield, average to normal yield and average to best yield). These regressions provide the most complete determination of inputs and farm conditions on agricultural productivity. As indicated in Chapter 4 when all 12 variables are used there are only 121 localities. Thus the approach (including step-wise regression) to reduce the number of candidate control variables to increase the number of localities is proffered and the tradeoff between reducing production variables and increasing localities to 151 discussed. Once the control variables are determined those results are discussed in detail. Finally the results from a model which eliminates all control variables but increases the number of localities to 201 is presented.

Because of the extensive number of tables generated from the econometric models, all results are listed in the statistical appendix to this chapter. Main body of the chapter refers to each Table, its results description and comparison. These extensive results are provided in full recognition that econometrics is at times more of an art than science and it is not unusual for researchers to sacrifice R^2 and overall efficiency in favor of a higher purpose. It is a worthwhile tradeoff to sacrifice efficiency of production control variables in order to gain efficiency in terms of localities or degree of freedom given the objectives of the study. However, because the tradeoff in efficiency is in some instances quite large, the complete set of regressions are exhibited for robustness and to illustrate the progression of the tradeoffs as the number of localities increase.

The unrestricted model is specified by

$$(1) \qquad \mathrm{Y_N} = 39.47 + \sum_{i=1}^{12} \alpha_i {X_i}^{CC} + \sum_{j=1}^{7} \alpha_j {D_j}^{A} + \sum_{k=1}^{21} \alpha_k {D_k}^{P} + \sum_{l=1}^{36} \alpha_l {D_l}^{T} + \epsilon$$

which identifies 4 groups of variables including 12 candidate control variables, 7 agricultural area variables, 21 provincial variables, 36 time variables (to capture the distinct periods in which surveys were taken). There are three dependent variables capturing the actual average yield by location, the average yield to normal yield ratio and the average yield to best yield ratio. The modeling approach follows to some extent the literature on whole farm production functions [93] where the input variables are determinants of output with an assumed linear response, and the three groups of dummy variables capturing the nascent effects of variance unexplained by the production variables. It is presumed that the production relationships are linear and additive and common across all villages, but does not assume that the production elasticities are common across villages. Productivity differences across space (villages) are captured by

[93] Turvey, C. G. and DeBoer, J. L. 1988. Farm-to-Farm Productivity Differences and Whole-Farm Production Functions. *Canadian Journal of Agricultural Economics* 36: 295-312.

the dummy variables of which agricultural area and provinces are fixed effects, while survey time-frame and calamities or conflicts are random effects.

These fixed and random effects are additively separable which also allows for a convenient interpretation of the variables using Analysis of Covariance[94] in multiple dimensions. These are joint effects, for example the combined (covariate) effect on productivity from province AND location or the joint (covariate) effect of province AND calamities or conflict etc.

To avoid multicollinearity certain variables were dropped from the regressions as appropriate because so many dummy variables are used in this study. In terms of the time variable, this research set the last period, from Nov. in 1932 to Oct. in 1933 (yr1932_11_1933_10), as the reference time, Hunan as the reference province, and the Rice-tea Area as the reference agricultural area.

5.1 Selection of Control Variables

As a first step equation (1) is run without the catastrophe variables to investigate the impact of inputs on agricultural productivity. These are presented in Figure 1.

[94] Adopted in Turvey, C. G. and DeBoer, J. L. 1988. Farm-to-Farm Productivity Differences and Whole-Farm Production Functions. *Canadian Journal of Agricultural Economics* 36: 295-312.

```
Linear regression                                      Number of obs =     121
                                                       F( 37,    65) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.7185
                                                       Root MSE      =  10.645
```

ratio_avg_to_normal	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
pct_crop_area_irri	.1626018	.0784671	2.07	0.042	.0058922	.3193114
sold_immediately_after_harvest	.1389866	.0717522	1.94	0.057	-.0043124	.2822857
all_farms_manequiv_per_farm	7.963603	5.045078	1.58	0.119	-2.112113	18.03932
all_farms_ind_doublecropping	.0845431	.0545034	1.55	0.126	-.0243077	.1933939
pct_cult_landarea	.0980431	.0795838	1.23	0.222	-.0608969	.256983
size_crop_hectare_area_mean	-3.480856	3.323585	-1.05	0.299	-10.11851	3.156802
num_parcels_per_farm	.2130357	.2433432	0.88	0.385	-.2729542	.6990255
avg_dist_of_farthest_parcels_km	3.076204	3.808182	0.81	0.422	-4.529261	10.68167
all_farm_fertilizer	.0001935	.000249	0.78	0.440	-.0003037	.0006907
all_farms_la	-6.990085	11.25181	-0.62	0.537	-29.4615	15.48133
total_mwd_pfn_in_marketing	-.0486366	.1028868	-0.47	0.638	-.2541158	.1568426
total_l_cost_yl	-.0097709	.0816719	-0.12	0.905	-.172881	.1533393

Figure 5.1 Regression Results with Robust Standard Error for Unrestricted Model with 12 Production Variables

To justify control variables, running unrestricted regression with all candidate variables but the dummy ones comes out with that only “pct_crop_area_irri” is significant at 4.2% level, crops sold immediately after harvest is significant at the 5.7% level and the man equivalent labor variable and double cropping variable are significant at slightly above 10% (11.9% and 12.6% respectively). The remaining variables are not significant at comfortable levels of p > 22%. Interpretation is other things being equal, of all households surveyed, average yield would rise 0.16 percent relative to normal yield of 1929 to 1933 when percent of crop area irrigated for all crops increases one unit compared with the corresponding change for Hunan in Rice-tea area during Nov. 1932 to

Oct. 1933. Irrigation as the foremost *Current Artificial Temporal*[95] should be the chief approach farmers relying on to contend against drought. Its positive effect on relative average yield change, however, is barely satisfactory as expected. On one hand, irrigation facilities were handmade. Its scarcity limited the scale and extent of irrigation. On the other hand, taxation of irrigated land ascended due to the finite existing irrigation even in years exactly after drought. Opportunity cost of irrigation thus increased and leaded to abandonment of irrigated land. This is why the coefficient turns out to be so small though irrigation is the most significant control variable across most of the regressions.

For the second variable, of all households surveyed, average yield would rise 0.14 percent relative to normal yield when percent of farm products sold immediately after harvest increases one unit ceteris paribus. It points out yield would be enhanced if farmers got encouraged from the fact that crop could be sold as long as being harvested. For the third variable, of all households surveyed between 1929 and 1933 average yield would rise 7.96 percent relative to normal when man-equivalent per farm for all farms increases one unit. The biggest number of coefficient in absolute value verifies the noteworthy positive effect that human labor input brought to relative average yield increase for intensive farming when machinery production was not available. For the fourth, given specific location of a village, the province and agricultural area it belongs to

[95] Reference Chapter 2:33.

is fixed as known as well as its index of double cropping. In other words, the designated locality would not be the original one if the double cropping index alters. Therefore it has little explanatory power for the relative average yield change besides its trivial 0.08 percent positive effect. For the fifth, undeveloped modern farming technology restricted the positive effect of reclaiming wasteland on to relative average yield increase. And information of land quality herein got lost more or less.

For the sixth significant production variable, of all households surveyed during 1929 to 1933, average yield would reduce 3.48 percent relative to normal yield when size of farm as measured by mean of crop hectare area increases one unit ceteris paribus. Size of farm did not determine yields in that mall farm ordinarily could not hold as much unproductive land as large farm did. Hence yields on small farms in several localities were even greater than on large farms, and the optimized farm size would vary in terms of family size, types of crops grown, and soil productivity. Moreover, for farms suffered from catastrophes such as the 1929 drought, 1931 flood or Japanese invasion, the larger the size, the greater the loss. For the seventh, given farm size and land quality, the more number of parcels a farm owned, the greater average yield that farm would acquire. For the eighth variable— “avg_dist_of_farthest_parcels_km”, the outcome violates common sense because average yield would rise 3.08 percent relative to normal when average distance of farthest parcels in kilometers increases one unit. But it might exactly reflect the historical truth: spacial diversification. If parcels were scattered with some on high land while others on low land, then the risk could be dispersed under the attack of locusts, wars, or even flood from the perspective of risk management. For the ninth, animal manure and night soil as daily fertilizer had negligible positive effect for that industrial production of effective fertilizers was unrealized in that era.

For the tenth variable indicating the marginal substitution between animal labor and man labor, the bigger the number, the more man labor input was required to improve relative average yield given that per unit of animal labor was fixed then. If man labor increase could not catch up with the marginal substitution rate, relative average yield would decrease thereby. For the eleventh— “total_mwd_pfn_in_marketing”, greater transaction cost of human labor in marketing would slightly lower farmers’ enthusiasm of raising yield. For the last, relative average yield would increase if more labor was invested into farming. Yet an increase of total labor cost does not necessarily imply an increase in labor because of the wage fluctuation. When calamities such as drought or flood came, relative yield probably decrease quite a bit instead of increase even though more labor was exerted at greater cost to save crops.

The problem with results in Figure 5.1 is that they hold over only 121 villages because of missing values. To increase the number of villages, step-wise regression is implemented to reduce the set of variables in the hope of increasing degree of freedom at village level observations. The final control variables is provided in Figure 5.2, which comes out at reduced R^2 of 0.62 compared to 0.72 in the full set of production variables in Figure 5.1. However by doing so the degree of freedom boosted to 151. Again, while the production coefficients are themselves meaningful, ultimately it is the fixed and random effects across as many villages as possible as being sought. The three variables displayed in Figure 5.2 are used in the remainder of the analysis except for a special case where they are removed entirely.

```
Linear regression                                  Number of obs =     151
                                                   F( 32,    94) =       .
                                                   Prob > F      =       .
                                                   R-squared     =  0.6236
                                                   Root MSE      =  11.023
```

ratio_avg_to_normal	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
pct_crop_area_irri	.1038958	.0739631	1.40	0.163	-.0429597	.2507513
avg_dist_of_farthest_parcels_km	2.628855	2.827861	0.93	0.355	-2.98593	8.24364
total_mwd_pfn_in_marketing	.154819	.0672988	2.30	0.024	.0211957	.2884423

Figure 5.2 Regression Results with Robust Standard error from Step-wise Regression for Ratio of Average to Normal Yields

$$\text{(2)} \qquad \mathrm{Y_m} = \mathrm{C_m} + \sum_{i=1}^{3} \alpha_i {X_i}^C + \sum_{j=1}^{7} \alpha_j {D_j}^A + \sum_{k=1}^{21} \alpha_k {D_k}^P + \sum_{l=1}^{36} \alpha_l {D_l}^T + \epsilon$$

Formula (2) specifies the regression for Figure 5.2. It has every term the same with formula (1) except that ${X_i}^C$ denotes for the three Control Variables.

5.2 Regression Results

Table A-1 to Table A-3 in Appendix posts results of regression with robust standard error for the unrestricted model without catastrophes. A decisive observation of these regressions is that the agricultural area fixed effects variables are largely insignificant in comparison to the provincial and time variables. This is different from what Buck had stated that the measures of productivity should be compared across agricultural areas and not necessarily provinces. Our results show that in fact the provincial effects are much more significant, probably tie to internal politics, culture, taxation etc.

Then rerun the unrestricted regression with three control variables, and the combination of any two groups of agricultural areas, provinces, or time span as independent variables. These are presented across Tables A-4 to A-6. Formula (2) summarizes the first set regressions across Table A-4 to A-6 for the three dependent variables respectively with m = 1 as the ratio of average to normal; m = 2 as the ratio of average to best; and m = 3 as index of average yield. Similarly, formula (3) specifies the second set regressions across Table A-4 to A-6 with control variables, agricultural areas, provinces as independent variables; formula (4) with control variables, provinces and time spans; formula (5) with control variables, agricultural areas and time spans.

$$(3) \qquad \mathrm{Y_m} = \mathrm{C_m} + \sum_{i=1}^{3} \alpha_i {X_i}^C + \sum_{j=1}^{7} \alpha_j {D_j}^A + \sum_{k=1}^{21} \alpha_k {D_k}^P + \epsilon$$

$$\text{(4)} \qquad \mathrm{Y_m} = \mathrm{C_m} + \sum_{i=1}^{3} \alpha_i {X_i}^C + \sum_{k=1}^{21} \alpha_k {D_k}^P + \sum_{l=1}^{36} \alpha_l {D_l}^T + \epsilon$$

$$\text{(5)} \qquad \mathrm{Y_m} = \mathrm{C_m} + \sum_{i=1}^{3} \alpha_i {X_i}^C + \sum_{j=1}^{7} \alpha_j {D_j}^A + \sum_{l=1}^{36} \alpha_l {D_l}^T + \epsilon$$

In Table A-4, total man work days per farm need in marketing products, appearing as "Market" for short to measure transaction cost of man labor in marketing, is single significant at 0.05 level among the three control variables across Table A-4 to Table A-6. Coefficient of "Market" in Table A-4 and Table A-5 can be interpreted as: other things being equal, one percent more transaction cost of man labor in marketing would bring 0.16 percent higher yield than normal yield on average, or 0.17 percent higher yield than best yield ever in 1929-1933, compared with the corresponding change of ratio in Hunan, Nov. 1932 to Oct. 1933. One percent more energy, time and the charge or fee a farmer invested in marketing as input, for instance transporting crops or other farm products to larger farm markets farther than nearby small markets by cart or carriage in person or hiring someone to do so, would bring him 0.16 percent increase on average yield compared with normal yield, or 0.17 percent rise on average yield compared with best yield. Earnings from larger markets trade might cover transaction cost, and encouraged farmers to reinvest a little more income onto farming and hence boosted the imminent average yield despite farmers could abandon land to evade warfare.

For the second group of independent variables— agricultural areas, take "DCR" (Double-cropping Rice Areas) in the second set of regressions for example, it is significant with zero p value and agricultural areas are not included in the third set of regressions. Of all households surveyed in double cropping rice area, ceteris paribus, average yield would increase 16.03 percent than normal yield. The beneficial *geographic physical prerequisite*[96] possessed by double cropping area is that heat and saturation are concurrent and last longer than in the Wheat Region; thus the double cropping system formed as advantageous *historical inherited convention* to keep good harvest. In addition, double cropping area comprised several southeast provinces such as Fukien, Kwangsi, Kiangsi, Kwangtung, which did not suffer that fatally from major calamity or conflict during 1929 to 1933 compared with other agricultural areas. It could be why the superiority of average yield relative to normal yield in double cropping area was obvious.

For the third group of independent variables— provinces, take Szechwan in second set of regressions with control variables, agricultural areas and provinces as independent variables for instance, it is significant with 0.02 for p value and provinces are not generally significant in third set of regressions. Of all households surveyed in Szechwan, ceteris paribus, average yield would be 10.95 percent higher than normal yield. Located within Szechwan basin, Szechwan province consists of the main portion of Szechwan

[96] Reference Chapter 2:24.

Rice Area. Plentiful minerals, including mines of coal, iron, natural gas, petroleum, salt, phosphorite, strontium, mirabilite etc, is contained in Szechwan basin which is also covered with large area of purple-brown forest soil— the richest in nutrients for planting. Along with the warm constant temperature and humid climate protected by Tibetan Plateau, Yunnan-Kweichow Plateau, and series of mountains around, Szechwan basin is called "land of abundance" because it was away from any severe calamity or conflict recorded in history and holds copious natural resources. Province of Szechwan fortunately escaped from any devastating event mentioned in China Weekly Review during 1929 to 1933 in the perspective of *current artificial temporal*, which accounts for its relative high average yield.

For the fourth group of independent variables— time span investigated, take "2901-3001" (Jan. 1929 to Jan. 1930) in third set of regressions for example, it is significant with zero p value. Of all households surveyed during Jan. 1929 to Jan 1930, other things being equal, average yield would be 38.86 percent lower than normal yield on average. China Weekly Review provides evidence for this phenomenon. A great famine arising in Shensi province in Dec. of 1928, resulted from the drought caused by rivers Wei and Kin drying out with reports of plague and locusts. 91 districts in at least 9 provinces got affected with reports of young girls being sold for marriage at a price of

$4-5. Brigandage pervaded thereafter.[97] Then in north China rains caused the Yungting River to overflow, inundating 10 villages. This occurred on August 5th of 1929 when nearly 1,000 feet of banking collapsed. Nearly 200 sq miles of land was flooded, with many persons drowned as well as thousands of cattle and all crops lost. Flooding eventually reached Peiping and Tientsin, Hopeh province. A section of the Peiping-Mukden (Shenyang) railroad line was washed away. By August 7th the Grand Canal was overflowing. Floods had affected nearly 500,000 people who in great starving numbers were living on the sides or tops of hills, which appeared as islands. The rains and floods were powerful enough to remove on its own the silt bed that was previously blocking shipping up stream to Tienstin.[98] Main drought, flood and famine as calamities spelled 1929 such an eventful year. Conflicts such as civil war with Feng Yu-hsiang towards a unified China, with Japanese intrusion in Shantung, Canton civil war were resolved at the end of 1929. Meanwhile Sino-Russian war averted and famine were on the mends.[99]

By the same token, readers can easily capture whatever macroscopic statistical and econometrical message needed to understand the change of average yield relative to normal or best yield on provincial level from 1929 to 1933. Results of four sets

[97] Editorial. *China Weekly Review* vol. 47.

[98] Editorial. August 3rd, 1929. Ten Villages Flooded in Chihli. *China Weekly Review* vol. 47: 446; Editorial. August 17th, 1929. North China Areas Devastated by Floods. *China Weekly Review* vol. 47: 529.

[99] Outline of China Weekly Review was organized by Professor Calum G. Turvey.

regressions are condensed in Table A-4 to Table A-6 to demonstrate outcomes of different combination for independent variables— including Control variables, Agricultural Areas, Provinces, and Time Span. Coefficient and p value for each group of independent variables are presented. A chief problem is that many coefficients are not significant. Though the third set regression behaves best on significance, agricultural areas are absent. This is probably because specific province signifies more detail information of location than agricultural area does since in most cases, province is smaller than agricultural area in size and is often contained within an agricultural area on scale.

Given normal yield and best yield for each locality is fixed up to 1933, the more the ratio of average yield to normal yield or best yield increases, the more the average yield within the year investigated would increase, the better relative yield was acquired, and vice versa. Average yield itself as dependent variable does not reveal as much information as the other two ratios for it is an actual index number. Defect of best yield being the reference substance is that extreme yield does not depicts the consistent condition farmers usually confront. Therefore, ratio of average yield to normal yield should be the core dependent variable among the three.

In short, Table A-4 is important, especially results of the third set regression. Table A-5 and A-6 can be theoretically skipped.

5.3 Calamities and Conflict in Rural China

Tables A-7 to A-10 in Appendix are the crucial ones for measuring the total effect of calamities and conflicts onto yields. By listing the coefficients of time span in the first column and coefficients of each province in the first row, and computing the sum of two numbers in whatever combination of both categories, in Table A-7 for example, readers can deem the sum as "covariance" of both categories. Readers can not only track the effect of catastrophe on average yield relative to normal yield of villages in Kansu province surveyed in period of Jan. 1931 to Dec. 1932, which are bolded and marked by a box as real recorded fact[100], but can also surmise what the compound effect would be if a village in Kansu was investigated in any other period of time. As well as how omitted values are dealt with, fake numbers of covariance that do not truly exist are kept for consistency. Owing to such tables created by modern econometrics, history can be assumed at this point.

Tables A-7 to A-10 provide regression results without the three control variables. By removing production variables, another 50 degree of freedom is earned at the cost of a tiny loss of R^2 that is less than 0.01. The overwhelming preoccupation is to gain more localities as observations. Such trade off precisely reflects the art of econometrics: to

[100] Reference Table A-13 in Appendix Part I for the corresponding period a locality is surveyed.

have covariance, information would go somewhere instead. Some is integrated into provinces and time spans, some goes into the intercept and even the error term.

In Table A-7— Coefficient and Covariance of Time Span and Provinces for Ratio of Average to Normal, the first row states the coefficient of province in the restricted regression with provinces and time span, setting ratio of average to normal as dependent variable. For example, other things being equal, in Shansi (it is significant with p value of 0.044) of all households surveyed, average yield would be 15.75 percent lower than normal yield recorded of 1929 to 1933. What should be noted is that the average yield refers to the average yield for the year to which the data pertain. Thus to label the time span investigated for each province in a box is necessary. The first column states the coefficient of time span investigated. Take the “3010-3110” (Oct. 1930 to Oct. 1931) for instance because it is significant with p value of 0.001. Of all households surveyed during this period, average yield would be 27.28 percent lower than normal yield ceteris paribus. Therefore the overall effect of province and time span would be minus 43.03 as covariance, which means of all households surveyed in Shansi province during Oct. 1930 to Oct. 1931, average yield would be 43.03 percent lower than normal yield ceteris paribus. In this way analysis of covariance captures the strong relationship between province and time.

$$(6) \qquad \mathrm{Y_h} = \mathrm{C_h} + \sum_{k=1}^{21} \alpha_k {D_k}^P + \sum_{l=1}^{36} \alpha_l {D_l}^T + \epsilon$$

Formula (6) summarizes the regressions for Table A-7 and Table A-9 with provinces and time spans as independent variables. When h = 1, it refers to Table A-7 with the ratio of average to normal as dependent variable; when h = 2, Table A-9 with the ratio of average to best.

For consistency and convenience, five provinces would be chosen as interpretation targets across Table A-7 to A-10 on behalf of five relative yield change level: Szechwan stands for the ***extraordinary above average***; Anhwei stands for the ***moderate above average***; Kwangsi represents the ***average***; Shensi stands for the ***moderate below average***; and Chekiang stands for the ***extraordinary below average***. Eight agricultural areas thus indirectly get involved for each target province belongs to one or more agricultural areas.

In Table A-7, other things being equal, in Szechwan of all households surveyed, average yield would be 3.87 percent higher than normal yield. Likewise, the time span coefficient shows positive effect of 22.3 percent on average yield relative to normal. Covariance reaches the extreme maximum of 26.17 as compound effect when it comes to “3107-3206”, implying that in Szechwan of all households surveyed during Jul. 1931 to Jun. 1932, average yield would be 26.17 percent higher than normal. In this case, however, Szechwan wins the rank for relative average yield in a way thoroughly different from its natural geographical advantage as “land of abundance” mentioned previously:

Szechwan suffered less disastrously compared with other provinces affected by 1931 Yangtze flood. By August 26th in 1931, the Yangtze River at Hankow was at 53.5 feet, even 3 feet greater than the recorded greatest flood of the year 1870 to 1871. In fact last time water in the Yangtze River at such level was in the 15th century, Ming Dynasty. Much of central China was flooded with 50 to 60 million people affected. 45 of 68 districts in Hupeh were flooded. 8,000 were known to have been drowned and 10,000,000 were rendered destitute. The destitute in Hunan, Kiangsi and Anhwei was estimated at more than 25 million. On August 22nd in Hupeh, 35,000 sqr miles were under water with 5 million refugees. Flood waters in Hunan covered 22,000 sqr miles with 2 million refugees. Deaths from starvation and disease in Wuhan (in Hupeh) alone exceeded 1,000 per day and corpses floated in the streets along with cats, dogs and livestock. People were living on the 2nd floor of houses that were still standing. 24 districts in Shantung were hit. In areas that were not flooded, locusts had consumed all crops leaving farmers destitute in famine conditions. In total, about 10,000 of the inhabitants along the Yangtze River were believed to be washed away in 1931. Szechwan Chengtu and Chungching were at most in not as bad a shape as Wuhan and Hankow.[101]

For Anhwei province in Table A-7, of all households surveyed, average yield would be 9.83 percent lower than normal yield ceteris paribus. Time span coefficient displays

[101] Editorial. August 29th 1931. Flood-Famine Situation Most Serious China Disaster since Fifteenth Century. *China Weekly Review* vol. 60: 495-499.

positive effect of 32.12 percent. Covariance hence comes to 22.29 as compound effect when it locates in “3205-3305”, indicating that in Anhwei of all households surveyed in May 1932 to May 1933, average yield would be 22.29 percent higher than normal. After 1931 flood, crop production began to resume. The only calamity occurred was a minor drought in northern Anhwei leading to another famine.[102] By Nov. 1931, communists expanded their revolutionary base area to southeast Anhwei very rapidly that Chiang Kai-shek had to finance another military drive, steadily rose to about 150,000 troops and perhaps 100,000 guns, against the communist armies. Former minister of finance T.V. Soong resigned as a political-military-economic solution intended to serve the destitute and discourage them from simply joining the Red Army to obtain food. Bandits arose in two forms: many bandit gangs started with food raids because of calamities and then progressed to territorialism; for the most part bandit gangs were simply looking for food. Rise in the ranks of the Red army came from peasants in Fukien, Kiangsi, Hunan, Anhwei and Hupeh provinces most affected by recent calamities of war and flooding then.[103] Communists recruited forces in rural areas by dedicatedly guiding and leading farmers to resume farming and production, and to resist suppression of communism launched by KMT (Kuo Min Tang). Though in late 1932, KMT declared that all Red

[102] Editorial. August 27th, 1932. Floods in Harbin Leave Population Destitute. *China Weekly Review* vol. 61: 491.
[103] Whang, P. K. July 2nd, 1932. Farmer Distress and Bandit Suppression. *China Weekly Review* vol. 61: 172.

Army forces were removed from Anhwei,[104] yet eight months later, it was found in Anhwei that about 30,000 communist forces were entrenched along the Honan-Hupeh and Anhwei border[105] since communist resisting suppression forces had routed the Red Army in Anhwei with the remnant to Honan for secret escape. Reasonable inference is that the strategy Communists designed to establish military confrontation power against KMT by attracting refugees, destitute farmers, bandit gangs who struggled hard for food to be organized as decent army, objectively resulted in concentrating on promoting farming and production. Manmade conflicts improved the average yield relative to normal yields.

For Kwangsi province in Table A-7, of all households surveyed, average yield would be 4.82 percent lower than normal yield ceteris paribus. Time span coefficient exerts positive effect of 10.08 percent. Covariance hence results in 5.26 as compound effect when it comes to “3201-3212”, implying that in Kwangsi of all households investigated in Jan. to Dec. in 1932, average yield would be 5.26 percent higher than normal. At that time, south Honan was affected by communist forces at 3 million reported by the Civil Ministry of Honan Province. A 30-year old commander of the main communist force used the same flags and orders as the regular army. Therefore as expected, thousands of

[104] Editorial. September 10th, 1932. Communists Executed at Tsinan. *China Weekly Review* vol. 62: 58.
[105] Editorial. May 20th, 1933. Offensive Against Kiangsi Communists Planned. *China Weekly Review* vol. 64: 453.

peasants in east Honan joined his forces in seek of food due to famine conditions.[106] Bandit suppression forces were active in Hunan, Kiangsi, Kwangtung, Kwangsi and Fukien at the time. Kwangsi is located adjacent to Hunan on the southwest provincially on map of China. Close latitudes of both provinces in range indicates the similarity of geopolitical and economic conditions. It adequately illustrates almost the same change level of average yield relative to normal that Kwangsi and Hunan share. Nevertheless the disparate agricultural area each province belonged to brings about slight difference on relative yield in that southeast of Kwangsi in Double-cropping rice area was with better natural geographical condition for farming than in Rice-tea area which northwest of Kwangsi and the entire Hunan also attached to. According to records in *China Weekly Review* for other periods within 1929 to 1933, generally Kwangsi suffered less calamities and conflicts than Hunan did. The leader of New China, Mao Cheh-tung was born and grew up in Hunan. As headstream of communists, Hunan played the role of central revolutionary base area quite often, which made Kwangsi relatively politically tranquil and enjoy better yields on average given Hunan as the reference substance.

For Shensi of all households surveyed, average yield would be 21.51 percent lower than normal yield ceteris paribus. Time span coefficient demonstrates positive effect of 9.21 percent. Covariance reduces to minus 12.30 at “3001-3012”, indicating that in

[106] Editorial. April 30th, 1932. The Campaign against Banditry and Communism. *China Weekly Review* vol. 51: 283

Shensi of all households investigated in Jan. to Dec. 1930, average yield would be 12.30 percent lower than the normal. This can be mostly elucidated by a report from China International Famine Relief Commission: wide-spread drought in Shensi was requiring burial squads to make two rounds per day in Sian.[107] The minor conflict factor that interrupted agricultural production could be that Chiang's troops were mobilizing in Honan to route Feng's troops back to Honan-Shensi border, to resist Chiang Kai-shek being ousted by the opposition government established in Peiping and being replaced by Marshal Yen His-shan as appointed chairman of the "Nationalist Government of China" on September 9th of 1930. Marshall Feng Yu-hsiang convened his troops against Chiang's in order to take charge of all military affairs and realign government towards unification of north and south.[108]

For Chekiang province of all households surveyed, average yield would be 5.13 percent lower than normal yield ceteris paribus. Time span coefficient offers negative effect of 27.28 percent. Covariance suddenly dropped to minus 32.41 at "3010-3110", implying that in Chekiang of all households investigated in Oct. 1930 to Oct. 1931, average yield would be 32.41 percent lower than the normal. Evidently Chekiang got affected severely to the extreme: by the beginning of August the Chientang River in

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[107] Editorial. June 14th, 1930. Acute Famine Conditions in Shensi Province. *China Weekly Review* vol. 53: 57.
[108] Editorial. September 13rd, 1930. Yen Heads Northern Government but Mukden Refuses Cooperation! *China Weekly Review* vol. 54: 46-48.

Chekiang was on the verge of overflowing due to heavy rains and many districts, notably Kahsing were inundated with flood waters.[109] Lying at the estuary of Yangtze River, northeast Chekiang on the low flat plain definitely would be the worst afflicted district in 1931 flood. As one of the major grain producing areas adopting intensive cultivation, Chekiang stretched across Yangtze-rice wheat area and Rice-tea area which could result in great loss when a tiny change in climate occurred. Chekiang also witnessed the major battlefront between republican forces and communists initiated in mountainous terrain of Kiangsi in mid July of 1931. The government force alone included 30 divisions, a troop strength of some 300,000 soldiers against 42,000 Red Army troops with 18,000 rifles. What was once considered a bandit force of extremist was now a significant force moving in and out of territories creating soviets along the way with purges of conventional leadership and the reallocation of land and wealth. By the end of 1930 many hsiens in Kiangsi, Hupeh, Hunan were fully Sovietized. Communist forces also had a presence in Anhwei, Szechuan, Fukien, Chekiang, Honan and Shantung. Though one major final aim of communists' revolution was to emancipate productive forces of the peasant through improving farm reconstruction and irrigation, enhancing prevention of floods and droughts, the support for emigration to reduce farm population density, the establishment of Farmer's Banks and cooperative societies to provide credit on easy

[109] Editorial. August 1st, 1931. Central Government to Grant Relief to Flood Stricken Areas. *China Weekly Review* vol. 57: 364.

terms, to unify currency, weights and measures, but the process itself impeded agricultural production at the beginning by recruiting farmers into armies that removed quite a lot of young able-bodied farmers away from farming.[110]

In Table A-9— Coefficients and Covariance of Time Span and Provinces for Ratio of Average to Best, the first row states the coefficient of province in the restricted regression with provinces and time span, setting ratio of average to best as dependent variable. For example, other things being equal, in Shansi (it is significant with p value of 0.001) of all households surveyed, average yield would be 30.06 percent lower than best yield recorded of 1929 to 1933. And the first column states coefficient of time span investigated. Take the "3205-3305" (May 1932 to May 1933) for instance because it is significant with zero p value. Of all households surveyed during this period, average yield would be 39.08 percent higher than best yield ceteris paribus. Thus the overall effect of province and time span would be 9.02 as covariance, which means of all households surveyed in Shansi province during May 1932 to May 1933, average yield would be 9.02 percent higher than best yield ceteris paribus.

Still the five provinces selected in Table A-7 will be discussed in Table A-9.

Other things being equal, in Szechwan of all households surveyed, average yield would be 5.90 percent lower than best yield. Likewise, the time span coefficient shows

[110] Chien, Y. July 25th, 1931. Canton Rebellion Likely to Throw All china into Ranks of Communists. *China Weekly Review* vol. 57:297-300.

positive effect of 27.87 percent on average yield relative to the best. Covariance reaches maximum of 21.97 as compound effect when it comes to “3107-3206”, implying that in Szechwan of all households surveyed during Jul. 1931 to Jun. 1932, average yield would be 21.97 percent higher than best. The outcome exactly corroborates the corresponding result in Table A-7, which means of all the households surveyed in Szechwan, the increase of average yield reached its maximum during Jul. 1931 to Jun. 1932 relative to normal yield as well as relative to the best yield of 1929 to 1933. A possible explanation is Szechwan suffered less gravely compared with other provinces affected by 1931 Yangtze flood.

For Anhwei of all households surveyed, average yield would be 23.26 percent lower than best yield ceteris paribus. Time span coefficient displays positive effect of 39.08 percent. Covariance hence comes to 15.82 as compound effect for “3205-3305”, indicating that in Anhwei of all households surveyed in May 1932 to May 1933, average yield would be 15.82 percent higher than best. Again, maximum of covariance rests on the same period investigated compared with in Table A-7. As stated previously, an interpretation would be: after 1931 flood, crop production began to resume. Manmade conflicts compositely enhanced average yield relative to best yield.

For Kwangsi of all households surveyed, average yield would be 15.54 percent lower than best yield ceteris paribus. Time span coefficient exerts positive effect of 15.55

percent. Covariance hence results in 0.02 as compound effect at “3201-3212”, implying that in Kwangsi of all households investigated in Jan. to Dec. 1932, average yield would be 0.02 percent higher than best. Kwangsi is next to Hunan on the southwest. Part of Kwangsi shares the same agricultural area— Rice-tea area with Hunan except that southeast of Kwangsi belonged to Double-cropping rice area which generates better yields than in Rice-tea area. Also, Kwangsi endured less calamities and conflicts to the extent than Hunan did. Setting Hunan as reference substance, Kwangsi seems relatively politically tranquil with better yields on average. That is why Kwangsi always appears similar with and even a bit better than Hunan on both average yield increase relative to normal and best.

For Shensi of all households surveyed, average yield would be 27.74 percent lower than best yield. Time span coefficient demonstrates positive effect of 13.49 percent. Covariance reduces to minus 14.25 as compound effect when it comes to “3001-3012”, indicating that in Shensi of all households investigated in Jan. to Dec. 1930, average yield would be 14.25 percent lower than the best. A famine as calamity and warlord troops’ mobilizing on geopolitical border of Shensi as a minor factor for conflict accounts for the moderate negative compound effect on relative average yield change both to normal and best yield.

For Chekiang of all households surveyed, average yield would be 15.61 percent lower than best yield. Negative effect of time span is 15.77 percent as coefficient. Covariance dropped down to minus 31.38 as compound effect for “3010-3110”, implying that in Chekiang of all households investigated in Oct. 1930 to Oct. 1931, average yield would be 31.38 percent lower than the best. Predominantly Chekiang got immediately affected devastatingly by 1931 flood to the peak in that northeast Chekiang was on the low flat plain lying at the estuary of Yangtze River. Besides, as densely populated grain producing province, Chekiang stretched across two agricultural areas of Yangtze-rice wheat area and Rice-tea area which could result in great loss when a tiny change in climate took place. Moreover, Chekiang got impaired by a major battlefront between republican forces and communists initiated in July of 1931. Therefore Chekiang is on behalf of the extreme negative compound effect on relative average yield change both to normal and best yield.

In conclusion, Table A-7 and Table A-9 converge to concordant outcomes for the representative five provinces.

Next a quick view is given for Table A-8 and Table A-10 since time span variables in these tables are not as significant as in Table A-7 or Table A-9.

In Table A-8— Coefficient and Covariance of Time Span and Agricultural Areas for Ratio of Average to Normal, the first row states the coefficient of agricultural area in the restricted regression with agricultural areas and time span, setting ratio of average to normal as dependent variable. For example, other things being equal, in winter wheat millet area (it is significant with p value of 0.007) of all households surveyed, average yield would be 14.93 percent lower than normal yield recorded of 1929 to 1933. Shensi province partially within winter wheat millet area proves its representativeness for the moderate below average level on relative yield change. The first column states coefficient of time span investigated. Take the “3010-3110” (Oct. 1930 to Oct. 1931) for instance because it is significant with zero p value. Of all households surveyed during this period, average yield would be 24.15 percent lower than normal yield ceteris paribus, which is the minimum of all numbers in this column. Thus the overall effect of agricultural areas and this time span would be in a range of minus 20 to 40 as covariance, which means of all households surveyed in whichever agricultural area during Oct. 1930 to Oct. 1931, average yield would be 20 to 40 percent lower than normal yield. Thus it can be seen the 1931 flood deserves to be claimed as major flood that influenced every agricultural area. The maximum of 30.55 which is significant with zero p value, emerges at the row “3205-3305” (May 1932 to May 1933) with the overall effect of agricultural areas and this time span in range of 15 to 31 as covariance, implying of all households surveyed in whichever agricultural area during May 1932 to May 1933, average yield would be 15 to 31 percent higher than normal yield ceteris paribus. Crop production resumed after 1931 performs its salience as is outlined in *China Weekly Review*. Such analysis of covariance captures the relationship between agricultural area and time.

While in Table A-10— Coefficient and Covariance of Time Span and Agricultural Areas for Ratio of Average to Best, the first row states the coefficient of agricultural area in the restricted regression with agricultural areas and time span, setting ratio of average to best as dependent variable. For example, other things being equal, in winter wheat millet area (it is significant with zero p value) of all households surveyed, average yield would be 19.15 percent lower than best yield recorded of 1929 to 1933 as minimum in this row. Shensi province partially within winter wheat millet area attests the verdict. The first column states coefficient of time span investigated. Take the "2901-3001" (Jan. 1929 to Jan. 1930) for instance because it is significant with p value of 0.004. Of all households surveyed during this period, average yield would be 19.96 percent lower than best yield, which is the minimum of all numbers in this column. Thereby the overall effect of agricultural areas and this time span would be in a range of minus 17 to 40 as covariance, which means of all households surveyed in whichever agricultural area during Jan. 1929 to Jan. 1930, average yield would be 17 to 40 percent lower than best yield. Hence the 1929 drought should be alleged as major drought incurring widespread catastrophe in every agricultural area. The maximum of 29.66, significant with zero p value, appears at the row "3205-3305" (May 1932 to May 1933) again with the overall effect of agricultural areas and this time span in range of 10 to 32 as covariance, indicating of all households surveyed in whichever agricultural area during May 1932 to May 1933, average yield would be 10 to 32 percent higher than best yield ceteris paribus.

$$(7) \qquad \mathrm{Y_h} = \mathrm{C_h} + \sum_{j=1}^{7} \alpha_j {D_j}^{A} + \sum_{l=1}^{36} \alpha_l {D_l}^{T} + \epsilon$$

Formula (7) summarizes the regressions for Table A-8 and Table A-10 with agricultural areas and time spans as independent variables. When h = 1, it refers to Table A-8 with the ratio of average to normal as dependent variable; when h = 2, Table A-10 with the ratio of average to best.

Table A-8 and A-10 are respectively another expression of Table A-7 and A-9. Information would be more rough and coarse for readers to acquire in Table A-8 or A-10 than in Table A-7 or A-9 because agricultural areas are larger in scale covered but less specific in tracking some locality compared with provinces. Meanwhile coefficients of time span perform better significance after agricultural areas are replaced with provinces in regressions. It can be inferred that more specific division of location would give rise to better significance of time span coefficients.

5.4 Removing the Manchurian Effect

The inclusion of the Japanese Manchuria conflict started in September 1931 through 1933. While there is a good argument for including the Japanese annexation of Manchuria because of the large effect it had on China's economy, as a random effect however, it is too broad and might be picking up noise from provinces or other time effects. As a robustness check this variable is removed. Table A-11 and Table A-12 are coefficient and covariance summary for the regressions of calamities and conflicts with ratio of average yield to normal yield or best yield set as dependent variable. After dummy variables of calamities and conflicts being put in to replace time span variables, many more provinces immediately become significant. Thus significance switches from time dummy variables to province dummy variables. Provinces convey sufficient information on analyzing influence of those calamity and conflict events. Among all the dummy variables of calamities and conflicts, “major_flood” (the 1931 flood overriding almost the whole Yangtze River) is the sole significant one. “major_drought”, “major_drought_plus_1”, “major_flood_plus_1” are quite closer to significant than variables of conflicts. Basically, nature catastrophes had much broader and more devastating impact on change of average yield relative to either normal or best yield than manmade conflicts did in the era of 1929 to 1933, no matter from the perspective of absolute value of coefficients or p value of significance.

For Table A-11 and A-12 in Appendix, the first row exhibits the coefficient of province while first column the coefficient of calamities and conflicts. In Table A-11, take Kwangsi for example because it is unique significant among the five provinces selected as representatives of different relative yield change level in discussion about Table A-7 to

A-10. Of all the households surveyed in Kwangsi during 1929 to 1933, average yield would be 10.63 percent lower relative to normal yield due to the presence of communists for revolution and relevant suppression battles to annihilate communists initiated by KMT ceteris paribus. Szechwan, standing for extraordinary above average level, survived after all major calamities and conflicts on average compared with Hunan. Major flood in 1931 swiped Shensi, Suiyuan, Honan, and Shantung along the Yellow River, Anhwei, Kiangsu, Hupeh, Kiangsi, Kweichow, and Yunnan flowed through by Yangtze River. When tracking the effect of major drought or flood, aftermath of post major drought or flood in a year should also be taken into account. All above analysis confirms the corresponding historic outline in *China Weekly Review* mentioned for the five representative provinces. The same logic is suitable and easily applied to Table A-12.

$$(8) \qquad \mathrm{Y_c} = \mathrm{C_c} + \sum_{k=1}^{21} \alpha_k {D_k}^{P} + \sum_{l=1}^{4} \alpha_m {D_m}^{Ca} + \sum_{l=1}^{4} \alpha_n {D_n}^{Co} + \epsilon$$

Formula (8) specifies the regressions for Table A-11 and Table A-12 with provinces, calamities and conflicts as independent variables. When c = 1, it refers to Table A-11 with the ratio of average to normal as dependent variable; when c = 2, Table A-12 with the ratio of average to best.

Both Tables A-11 and A-12 can measure the relative effect of disparate catastrophe factors compared with Hunan undergoing Japanese intrusion and assign the effect onto each province, as evaluating weight of different catastrophe factors for every province. In

Anhwei for moderate above average level, major drought brought negative effect on relative yield up to minus 21.77, for major flood, it is minus 16.29, communism minus 11.23, and communist suppression minus 12.58. In Shensi for moderate below average level, the negative effect of major drought reaches minus 26.43, major flood minus 20.42, while civil war merely minus 10.99. At last in Chekiang for extraordinary below average level, negative effect of major drought is minus 29.11 however, minus 10.02 for communism. If a line is inserted to split calamities and conflicts into two halves as presented in both tables, readers would have no difficulties to find that for all the negative effect of catastrophes, the least absolute value for calamites would be greater than the supreme absolute value for conflicts. Kiangsi is an exception in that Red Army chose Ruijin as center for revolutionary base area in 1930 and in Nov. 1931 communists set up the Soviet Republic of China. Peasants and workers were profoundly encouraged by communists to resume farming and production for embracing a new world dominated by themselves that all land and wealth could be reallocated according to their labor achievement. By then such ideal administrative program had not been generalized and accepted as well in other provinces as in Kiangsi, therefore covariance for communism and communist suppression are still negative for all other provinces. In a word, nature calamities had greater power than manmade conflicts had during 1929 to 1933 on impairing relative average yield regardless of significance or absolute value of the effect.

Kiangsi was an exception to have the effect of communists' activities being positive due to its internalization of communism as the first province.

Northern war had the least influence than other seven catastrophes since it happened in 1926 to 1928, too early to be considerable. So it is for the civil war, few provinces seldom got vandalized. Time and energy of peasants in 1929 to 1933 focused primarily on how to response the overwhelming nature calamities, as in *the Good Earth*, Wang Lung's family fled from hometown in Anhwei as refugees after all possible food, even his loyal friend—the ox, being exhausted. Warlords faded away. Japanese stealthily crept over most of China. Reports about communists as ordinary bandits at first gradually expanded in length and importance in *China Weekly Review*.

5.5 Summary

For every table in this chapter, Hunan province, Rice-tea area, the last time span of Nov. 1932 to Oct. 1933, and Japanese or Manchuria intrusion are removed as reference substance, therefore the contrast between the target described and this reference substance can be ignored at will for results analysis.

To justify control variables, coefficient of 12 production variables without any dummy variables in the unrestricted model are posted, reported and interpreted by the rank of significance. By dropping "pct_cult_landarea" on purpose, degree of freedom rise by 30 at the cost of a negligible loss for R^2. Step-wise selection with ratio of average to normal yield as dependent variable output irrigation, average distance of the farthest parcel, and transaction cost of man labor in marketing as control variables for the next 12 regressions.

In Tables A-4 to A-6 in Appendix, each of the four groups of independent variables is interpreted by choosing one example that is representative on behalf of every group. Four sets of regressions are run and summarized in these three tables to demonstrate outcomes of different combination for independent variables— including Control variables, Agricultural Areas, Provinces, and Time Span. Coefficient and p value for each group of independent variables are provided. Chief problem is that many coefficients are not significant. Though the third set regression behaves best on significance, agricultural areas are absent.

Also, average yield itself as dependent variable is not a proper choice since information of relative yield is missing. Neither is the ratio of average to best yield. Extreme yield does not reflect the typical condition farmers usually confront. Therefore, ratio of average yield to normal yield comes out to be the kernel dependent variable among the three.

Hence Table A-4 is important, especially for results of the third set regression. Table A-5 and A-6 can be theoretically ignored.

Table A-7 to A-10 in Appendix are critical for measuring the total effect of calamities and conflicts onto yields. Compound effect as covariance of relative average yield change for province and time span investigated can be tracked in terms of numbers marked in boxes. Fake numbers of covariance are kept for consistency.

Five provinces are selected as interpretation targets across Table A-7 to A-12 on behalf of five average yield change level: Szechwan stands for the extraordinary above average; Anhwei stands for the moderate above average; Kwangsi represents the average; Shensi stands for the moderate below average; and Chekiang stands for the extraordinary below average.

Whether covariance of relative average yield change for each of the five representative provinces is caused by natural calamities or human conflicts, is verified by searching and gathering written evidence within volumes of *China Weekly Review* for 1929-1933. Explanations for the average yield change relative to normal in Table A-7 and the average yield change relative to best in Table A-9 converge to concordant results for the representative five provinces.

Table A-8 and Table A-10 in pair is another expression of Table A-7 and Table A-9 separately. Information is more crude and sketchy to obtain in Table A-8 or A-10 than in Table A-7 or A-9 because agricultural areas are larger in scale but less specific compared with provinces. Coefficients of time span display better significance after agricultural areas being replaced by provinces in regressions. More specific division of location would give rise to better significance of time span coefficients.

Table A-11 and Table A-12 in Appendix are covariance summary for the regressions of calamities and conflicts with ratio of average yield to normal yield or best yield set as dependent variable. After events variables being put in to replace time span variables, significance instantly switches from dummy variables of time to of province. Basically, nature calamities had much broader and ravaging influence on the change of average yield relative to either normal or best yield than human conflicts did in the era of 1929 to 1933, no matter from the perspective of absolute value of coefficients or p value of significance.

Quintessence of Table A-11 and A-12 shows relative effect of disparate catastrophe factors that can be compared on provincial level, as measuring weight of different catastrophe factors for every province. Nature calamities were more powerful than human conflicts during 1929 to 1933 on undermining relative average yield regardless of significance or absolute value of covariance.

Chapter 6: CONCLUSION

The purpose of this thesis is to investigate the consequences of calamities and conflicts on agricultural productivity as measured by Buck's data, 1929 to 1933. More specifically the objectives are to explore the relation between specific events of calamity or conflict and agricultural productivity; to check the extent to which agricultural productivity depended on the time surveyed or on the location of provincial level; to study the impact of natural calamity and manmade conflicts on agricultural productivity; and to compare the effect of both categories of catastrophes.

In the era of 1929 to 1933, China faced a host of calamities and conflicts. Even in areas not vested in civil war, anti-communist campaigns or communist insurgency, roving warlords left over laid the havoc to rural regions: to maintain the warlord army, farmers were taxed senseless. But different from what is mentioned in Introduction that the remnants of warlord period induced disaster on farm income and consumption, poverty in China was chiefly driven by natural calamities according to our data results. Without technological adaption such as irrigation, genetic modification to mitigate the impact of climate transilience, nature calamities in 1929 to 1933 were not trivial norm when to resolve the yield change.

Contrary to Buck in Literature Review, agricultural regions and areas are not that effective as units for understanding agriculture than political units of provinces in our findings. Though the boundaries of agricultural areas may capture some homogeneous economic or physical conditions, they lose more information about specification of every locality such as tax rate, the language coverage, and esoteric sales channel to lessen transaction cost, etc.

Water, too much (flood) or too little (drought), was the greatest element affecting farming in China. And flood or drought was the main reason for famines. According to Buck, highest number of famines occurred in the Szechwan Rice and the Winter Wheat-millet Areas. Famines were more severe in the Wheat Region than in the Rice Region, in the Spring Wheat and Winter Wheat-millet Areas than in the Winter Wheat-gaoliang Area, and in the Szechwan Rice Area than in other areas of the Rice Region.[111] Risk in farming was much greater in Wheat Region than in Rice Region due to the low and variable precipitation which limited crop yields in spite of the inherently richer soils. However, partially agrees with that Winter Wheat-millet Area acquires the most negative effect on average yield change from catastrophes, Szechwan Rice Area is the unique one showing positive effect on relative yield change to either normal or best yield. Though it is true that the compound negative effect was more noteworthy in Wheat Region than in the Rice Region, in the Spring Wheat and Winter Wheat-millet Areas than in the Winter Wheat-gaoliang Area, to the opposite, Szechwan Rice Area performs the

[111] Buck, J. L. 1937. *Land Utilization in China* Chapter IV: 125.

best among all the five Rice Areas.

An explanation for this could be that famine does not appear as a separate variable in our regressions, it is included in the variable “major flood/drought plus 1” which depicts the aftermath of major calamities such as famine. And Buck did not define the word “severe” clearly. There could be most famines in number in Szechwan but least negative effect on average yield change. Moreover, other variables of conflicts such as communists’ policies for resuming agricultural production to resist against the suppression from KMT may promote relative yield to an extent that the positive effect can offset the negative brought by famines and finally results in the positive as composite effect. Chapter of “Model Development and Econometric Results” discusses a little about the above disputes for Table A-8 and Table A-10 (in Appendix) which present even the best significance result among all the combinations of different groups for independent variables with agricultural areas, are both not significant in general.

All factors that affected agricultural productivity are sorted into three groups by the author of this thesis: *Geographic Physical Prerequisite*, includes climate, topography and soil; *Historical Inherited Convention*, includes the type of the land use (excess reclamation, fragmentation), the tenancy relationship, racial custom (ready cash for conspicuous delicacies on momentous occasions, dense population), and the prior sales channel; and *Current Artificial Temporal*, includes irrigation system, animals as labor and offering livestock waste as fertilizer, size of farm, and trends of price. Calamity, such as flood, drought, famine, wind, frost, hail and even insects, can be triggered by any factor in either group or in combined groups and it is supreme in this thesis since China was exposed to frequent catastrophes so severe that those calamities undoubtedly exerted an important effect on reproductive performance. Some factors are across-group: Transaction cost was shaped through both *Geographic Physical Prerequisite* and *Historical Inherited Convention*. Great distances across the whole China with primitive methods for transportation, such as carrying goods by a pole over the shoulder, or by cart and junk, made access to markets a fundamental factor in determining the type of production. Though rail and steamboat transportation was increasing, predominant methods were still the laborious and inefficient ones. People in Rice Region had become so habitualized to rice that they continued to make it the chief staple of their diet, even when it was more expensive than wheat. This is the case how *Current Artificial Temporal* converted to *Historical Inherited Convention* when the experience is restricted without innovation.

What should be criticized is Buck never placed any of the statistical data in context. China between 1929 and 1933 was in tumult with a variety of natural calamities and manmade conflicts and each of these could qualify the data. To add complexity many of the village names no longer appear in current maps or have been changed so that it is not possible to readily pinpoint precisely where a particular village was located. Also, not every particular village was provided the time it was exactly surveyed. For the locality lying in a war zone, it might have been surveyed before, after, or during the war if the village was not that close to the front line. Thus the randomized survey protocol was not thoroughly practical and the homogeneity principle of the ceteris paribus assumption for the outcomes would be doubtful, and results must be interpreted in the context of the historical developments at the time.

The summary of context is entirely reliant on the contemporaneous news reported in the weekly volumes of *China Weekly Review* (CWR). It provides continuity of depth on any particular issue drawing from its own reporters and editors as well as other contributions from Chinese and English (and Japanese) language dailies and weeklies. It also picks up regional news sources as well as items of national importance. It is yet unlikely that the news made available is entirely complete. Based on the fact that any action rose to serious threshold in all likelihood was recorded, it is believed major calamities and conflicts facing rural China are all caught between 1929 and 1933.

For calamities and conflicts, the main events were the 1929 drought and famine, the 1931 flood, communist insurgency and warfare with the KMT, banditry and civil war, and the Japanese intrusion. Not that surprisingly, no significant results for conflicts on appreciating agricultural productivity could be from Buck because he did not select hsiens in active bandit or warfare zones.

As prerequisite of all models developed and tables formed, four dummy variables including Hunan province, Rice-tea Area, last time span of Nov. 1932 to Oct. 1933, and Japanese invasions and annexations of Manchuria, are removed as reference substance. All the regression results of coefficient and covariance are relative to above reference substance thus any contrast between the outcomes presented can be proceed without mentioning the reference substance at all.

The ratio of average to normal yield conveys more desirable information about typical yield level than the ratio to the extreme yield of best or the index of average yield itself. Thus the three control variables involved in the main twelve regressions are screened out according to step-wise selection for the ratio of average to normal yield. Given normal yield or best yield of 1929 to 1933 as fixed number, average yield change relative to normal or best yield turns out to be substitutable with average yield change in discussion.

In the process to justify control variables, only percent of crop area irrigated is significant at 0.05 level almost all the way through. Irrigation as the prime *Current Artificial Temporal* should be the main method farmers counting on to contend against drought. Its positive effect on promoting relative yield increase on average, however, is not evident as expected. Reason for this is irrigation facilities were handmade. Farmers dig wells and canals themselves. Limited scale of irrigation confined the efficiency supposed to be remarkable to a large extent. Furthermore, taxation of irrigated land ascended due to the finite existing irrigation even in years exactly after drought. Opportunity cost of irrigation hence increased, leading to abandonment of irrigated land.

For the second candidate control variable, percent of farm products sold immediately after harvest, ranked by significance in the unrestricted regression with whole pack of 12 production variables except for the dummy ones, the infinitesimal positive effect on relative yield rise points out that farmers could not afford to store grain for future sale due to a host of senseless heavy taxes needed to be paid in cash when pressed at harvest without general access to credit available. Though sometimes price was high enough to enable the person hold grains for profit regardless of the storage risk of insects, rodents, dampness, fire and theft, abundance lowered such price when all farmers sold agricultural products simultaneously, so that any possible benefit for storing post harvest was transferred to the marketers and wholesalers.

In times of scarcity, due perhaps to drought, farmers without crop for selling, could not afford steep rise in prices that accompanied famine. Even if there was surplus worth selling, often the commodities could not be moved. Local price spread of rice might be $17/picul between Sian (Xi'an) and south Shensi. But transaction cost such as exactions along the way by "special" tax collections, extortion by agents and city gate keepers, bandits, and lack of communication with potential buyers would make the venture perilous and even unprofitable for the merchants who assumed to profit by transporting rice from south to north. This expounds the slight negative effect on relative yield increase incurred by a control variable, total man work days per farm need in marketing products, signifying transaction cost of human labor.

The last control variable— average distance of farthest parcels in kilometers moderately increased average yield relative to normal. To satisfy the interest of most farmers pursuing good land quality under the restriction that only half the total land resided in the first class, land fragmentation was prevalent. Though it had disadvantages of increasing the number of boundary disputes, consuming time to reach the plots (nearly six pieces, or parcels, per farm averaging a little less than an acre in size), increasing the difficulties of irrigation, restricting the size of fields for machinery farming (also dense population makes labor cheap and machinery operation uneconomical), and making integrated crop protection difficult. But this might precisely tell a story of spatial diversification for farmland, resorted to which farmers unwittingly realized risk management. It was vital to have land of differing qualities in a country of small farms where a complete crop failure would be disastrous. If parcels scattered on high land and low land as well, risk would thereby be dispersed under the attack of locusts, wars, or even flood.

Other candidate control variables except for the dummy ones manifest the production theory of positive correlation between the change of input and of output. For instance, human labor invested performed outstandingly on improving average yield. Absent industrious farming technology restricted the positive effect of reclaiming wasteland. The optimized farm size would vary in terms of family size, types of crops grown, and soil productivity. Given information of land quality missing, total effect of farm size was negative in that for farms wrecked by catastrophes such as 1929 drought, 1931 flood or Japanese invasion, the larger the size, the greater the loss. Number of parcels per farm played a cameo role on obtaining better yield. So it was for double cropping index, indicating type of crops grown and times of harvest within a year. Fertilizer and cost of man labor were nearly neutral because animal manure and night soil as daily fertilizer was inefficient and increase of man labor cost would not necessarily raise yield in case of calamities even though more labor was exerted at greater cost to save crops. Obvious negative effect of marginal substitution between animal labor and man labor implies if input of man labor could not reach the total amount required measuring in animal labor, average yield would thereby decrease.

In summary of four sets regressions for average yield, ratio of average to normal and best yield, the third set of regression with three selected control variables, provinces, and time span as independent variables exhibits the best significance results among the twelve regressions. Transaction cost of man labor in marketing is the single significant among the three control variables across Table A-4 to A-6. Transporting crops or other farm products to big cities or larger farm markets by carts or carriage would bring the farmer subtle rise on yield due to exactions and extortions in form of taxes along the way. Positive effect on yield rise is apparent in Double-cropping Rice Area due to the advantageous geographic physical prerequisite it possesses: rain and heat are concurrent to bring cropping twice per year and provinces inclusive did not gravely suffer from any serious calamity or conflict during 1929 to 1933 compared with other agricultural areas. Surrounded by plateaus, Szechwan is called "land of abundance" with best performance on average yield increase because it was away from any devastating event and is covered with large area of most nutritious soil for planting. Year of 1929 with great famine arising after the major drought in late 1928, 1931 with major flood in regions of both Yellow River and Yangtze River, 1932 with communists revolted, being suppressed, and Japanese invasion expanded, but agricultural production resumed, were the main periods both influential and significant.

To mend the problem that many coefficients are not significant, results of regressions with simply dummy variables of time span and provinces are provided in Table A-7 and A-9 in Appendix as the critical condensation for catastrophe analysis. Control variables are removed to release quite a lot degree of freedom at little cost of R^2.

Provinces are kept to replace agricultural areas in terms of its comparative advantage on specific location. Except the bolded ones labeled in boxes capturing the compound effect of province and time span investigated on yield change, other numbers as covariance are predicted fake value automatically generated by econometric software.

Five provinces are chosen as interpretation targets across Table A-7 to A-12 on behalf of five relative yield change level: Szechwan stands for the ***extraordinary above average***; Anhwei stands for the ***moderate above average***; Kwangsi represents the ***average***; Shensi stands for the ***moderate below average***; Chekiang stands for the ***extraordinary below average***.

Szechwan got less disastrously impacted compared with other provinces affected by 1931 Yangtze flood. In Anhwei, a minor drought in northern part incurred another famine. But the dominant positive effect stems from resume of agricultural production after the 1931 flood. The tactic Communists elaborated to build army against KMT by attracting the destitute struggling desperately for living, actually resulted in concentrating on promoting yield as positive effect. Kwangsi was almost in the same situation with Hunan politically and economically since the two provinces are adjacent to each other. South Honan and other nearby four provinces including Kwangsi was affected by recruit of communist forces and the anti-suppression fights on a large scale. It is the different agricultural area from Hunan that Kwangsi belonged to brought about the diminutive relative superiority on yield increase. For Shensi a minor but wide-spread drought starved many adult labor men to death. Conflict factor that interrupted agricultural production was the civil war between warlords on the border of Shensi. Relative yield dropped strikingly in Chekiang because it suffered severely to the extreme from the 1931 flood as low land estuary of Yangtze River and major grain producing area adopting intensive cultivation. A major battlefront between republican forces and communists exacerbated the negative impact. Results of average yield change relative to normal are in line with the change relative to best for the representative five provinces.

Of all agricultural areas listed, winter wheat millet area, which Shensi partially within, was basically the worst on yield improvement while Szechwan rice area was the best though the latter is not significant. Oct. 1930 to Oct. 1931 is the period with the most negative effect. Overall effect of agricultural areas investigated in this time span would be in a range of minus 20 to 40. Hence the 1931 flood deserves to be claimed as major flood that damaged every agricultural area. The greatest positive effect emerges in the period of May 1932 to May 1933 with covariance between 15 and 31. Crop production resumed after 1931 performs its salience as is outlined in *China Weekly Review*. Single difference between extremums of significant observations for average yield relative to normal and to best is the most negative compound effect appears in Jan. 1929 to Jan. 1930 when it comes to Table A-10. Therefore the 1929 famine after drought in late 1928 should be alleged as major drought. Table A-8 and A-10 are respectively another expression of Table A-7 and A-9. Besides, the more specifically the division of location is, the better significance that coefficients of time span would present.

After dummy variables of calamities and conflicts being put in to substitute time span variables, many more provinces immediately became significant. The switch of significance from time variables to province variables reveals that those calamity and conflict events can be analyzed rather sufficiently on provincial level. The 1931 major flood is the sole significant one among all event dummy variables. The variables referring to the 1929 major drought and its aftermath, the repercussion of 1931 flood are fairly closer to significant than variables of conflicts. Essentially nature catastrophes had much broader and more devastating impact on the change of yields relative to either normal or best yield than human conflicts did in the era of 1929 to 1933.

Analysis of covariance in Table A-11 and A-12 for the five representative provinces confirms the corresponding historic epitome in *China Weekly Review* and the outcomes mentioned in analysis for Table A-7 to A-10. Quintessence of Table A-11 and A-12 is both tables can measure the relative effect of each catastrophe factors compared with Hunan undergoing Japanese intrusion and assign the event effect onto each province, thus the influence of different catastrophe factors can be compared for every province. If a line is inserted to split calamities and conflicts into two halves as presented in both tables, of all the negative effect of catastrophes, the least absolute value for calamites would be greater than the supreme absolute value for conflicts. In a word, nature calamities mastered relative yield with greater domination than human conflicts did during 1929 to 1933 on average. Kiangsi was an exception to have the effect of communists' activities being positive due to its internalization of communism as the first center for revolution.

Northern war had the least impact than other seven catastrophes since it happened in 1926 to 1928, too early to be considerable. So it is for the civil war between warlords, few provinces seldom got vandalized. Time and energy of farmers in 1929 to 1933 concentrated chiefly on how to response the overwhelming nature calamities, as in *the Good Earth*, Wang Lung's family fled from hometown in Anhwei as refugees after all possible food[112], even his loyal friend— the ox, being exhausted. Japanese stealthily crept over most of China. Reports about communists as ordinary bandits at the beginning gradually expanded in length and importance in *China Weekly Review*.

Potential defects root in that "ceteris paribus" could not be realized in reality. Condition of the era in 1929 to 1933 can be deemed as a natural experiment in which

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[112] *Wang Lung, sitting at the threshold of his door, said to himself that now surely something must be done. They could not remain here in this empty house and die…*

Ching thrust his face nearer. "In the village they are eating human flesh," he whispered. "It is said your uncle and his wife are eating. How else are they living and with strength enough to walk about—they, who, it is known, have never had anything?"

Wang Lung drew back from the death-like head which Ching had thrust forward as he spoke. With the man's eyes close like this, he was horrible. Wang Lung was suddenly afraid with a fear he did not understand. He rose quickly as though to cast off some entangling danger.

"We will leave this place," he said loudly. "We will go south!"

Buck, P. S. 1931.*The Good Earth*: 79.

modern industrial farming facilities and machinery farming or harvest were not available at all in general for the rural China. It can be examined without modern risk management such as irrigation, protection against insects, floods, hails, winds… or even hedging tools, what effects of calamities and conflicts on agricultural productivity might be. Nevertheless, the requirement of "other things being equal"— only one catastrophe is allowed for a special locality during a designated period of time is impractical. In some areas none of those events occurred while in others all of the events occurred. Not to mention the ceteris paribus for control variables as input factors for yield.

Also, even though Buck's team conducted a far-reaching survey across most provinces in China, Buck would not send his students to unsafe locations such as battlefield and disaster areas. Hence the selectivity problem still cannot be thoroughly avoided for villages investigated.

What is more, for every regression with robust standard error, constant is retained because zero mean of residuals is guaranteed thereby. With deletion of constant, regression line would be forced to go through the origin, implying that all of the independent and the dependent variables must equal zero at that point. If the fitted line does not intrinsically pass the origin, corresponding regression coefficients and predictions would be biased in the case of constant being omitted. However, in the interpretation for summary tables, the constant is not added back to acquire coefficient or covariance for that any lost information excluded in independent variables has a chance to go into either constant or error, which is not clear up to now. Further, many constants are definitely too big to be added on coefficient or covariance without changing its sign. And the sign is vital to determine whether the compound effect was positive or negative.

Last but not least, the method of linear regressions with robust standard error and analysis of covariance have been queried for being too simple. Due to the tumultuous years in Chinese history, the data of yield and catastrophes in 1929 to 1933 is too scarce and limited in numerous missing values to be directly adopted. Existing data relevant with catastrophes in Buck's Statistics of *Land Utilization in China* is reported in total amount on agricultural areas' level without specifying the time and location for each calamity. Data about conflicts is completely absent. Restricted by such difficulties, researchers have to read piles of volumes of weekly news for the five years and create dummy variables about catastrophes according to the events summary by themselves. Based on what mentioned above, linear regression is accepted in terms of the linear relation between input and output in production theory. Complicated econometric model or operation can hardly be applied onto a database filled with lots of omitted observations. Regression with robust standard error in addition is beneficial to eliminate heteroskedasticity. The covariance is generated by merely adding up two coefficients in row and in column for it is not possible to measure the weight of dummy variables in incomparable categories such as catastrophe, location and time.

In conclusion, this thesis examines the effects of calamities and conflicts on agricultural productivity in rural China during 1929 to 1933. The data, when mapped against the contemporaneous calamities or conflicts in that era provides a rare glimpse into the agricultural economics of disaster. Empirical part of this thesis is essentially geared to understanding how calamities and conflicts and other natural and geopolitical influences can collectively or individually explain the productivity measured in Buck's study.

To investigate this, our regressions use productive controls, and a series of dummy variables to capture the time frame, provincial or agricultural regional factors. In addition, a number of variables are then added to apprehend the flood, drought; communist, bandit, warlord, other civil military activities, Japanese militarism and other factors. Contrary to Buck's focus on agricultural areas, our findings prove that the significant differences in productivity are tied to provincial. Typically nature catastrophes had much broader and more devastating impact on the change of yields relative to either normal or best yield than human conflicts did in the era of 1929 to 1933.

Realistic illuminations for this thesis include a greater depth of understanding the economics of catastrophe. A chance is given to measure the social benefits of modern technologies by exploring the opportunity costs associated with the absence of technological adaptation such as irrigation and genetic modification designed to mitigate wide agricultural productivity fluctuation incurred by climatic variability. Only a retrospective study of this sort can truly benchmark for such measures.

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APPENDIX

Part I: Statistical Appendix to Chapter 5— Code and Table A-1 to Table A-12

Unrestricted OLS Regression for Ratio of Average to Normal:

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regress ratio_avg_to_normal pct_crop_area_irri sold_immediately_after_harvest all_farms_manequiv_per_farm all_farms_ind_doublecropping pct_cult_landarea size_crop_hectare_area_mean num_parcels_per_farm avg_dist_of_farthest_parcels_km all_farm_fertilizer all_farms_la total_mwd_pfn_in_marketing total_l_cost_yl spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r regress ratio_avg_to_normal pct_crop_area_irri sold_immediately_after_harvest all_farms_manequiv_per_farm all_farms_ind_doublecropping pct_cult_landarea size_crop_hectare_area_mean num_parcels_per_farm avg_dist_of_farthest_parcels_km all_farm_fertilizer all_farms_la total_mwd_pfn_in_marketing total_l_cost_yl spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01
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yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Table A-1 Unrestricted OLS Regression for Ratio of Average to Normal

```
Linear regression                                      Number of obs =     121
                                                       F( 37,     65) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.7185
                                                       Root MSE      =  10.645
```

ratio_avg_to_normal	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
pct_crop_area_irri	.1626018	.0784671	2.07	0.042	.0058922	.3193114
sold_immediately_after_harvest	.1389866	.0717522	1.94	0.057	-.0043124	.2822857
all_farms_manequiv_per_farm	7.963603	5.045078	1.58	0.119	-2.112113	18.03932
all_farms_ind_doublecropping	.0845431	.0545034	1.55	0.126	-.0243077	.1933939
pct_cult_landarea	.0980431	.0795838	1.23	0.222	-.0608969	.256983
size_crop_hectare_area_mean	-3.480856	3.323585	-1.05	0.299	-10.11851	3.156802
num_parcels_per_farm	.2130357	.2433432	0.88	0.385	-.2729542	.6990255
avg_dist_of_farthest_parcels_km	3.076204	3.808182	0.81	0.422	-4.529261	10.68167
all_farm_fertilizer	.0001935	.000249	0.78	0.440	-.0003037	.0006907
all_farms_la	-6.990085	11.25181	-0.62	0.537	-29.4615	15.48133
total_mwd_pfn_in_marketing	-.0486366	.1028868	-0.47	0.638	-.2541158	.1568426
total_l_cost_yl	-.0097709	.0816719	-0.12	0.905	-.172881	.1533393
spring_wheat	-7.140262	24.67526	-0.29	0.773	-56.42015	42.13963
winter_wheat_millet	9.406598	17.2839	0.54	0.588	-25.11174	43.92494
winter_wheat_gaoliang	19.01869	14.74887	1.29	0.202	-10.43685	48.47422
yangtze_rice_wheat	.9531678	12.10076	0.08	0.937	-23.21372	25.12006
szechwan_rice	0	(omitted)				
double_cropping_rice	20.79416	16.53365	1.26	0.213	-12.22581	53.81413
southwestern_rice	32.44976	18.18624	1.78	0.079	-3.870665	68.77018
kansu_sw_wwm	43.65887	25.6713	1.70	0.094	-7.610264	94.92801
ningsia_sw	0	(omitted)				
shansi_sw_wwm	28.86927	23.80082	1.21	0.230	-18.66425	76.40279
shensi_sw_wwm_sr	15.19689	26.91727	0.56	0.574	-38.56062	68.95439
suiyuan_sw	0	(omitted)				
tsinghai_sw	0	(omitted)				
honan_wwm_wwg_yrw	10.89909	19.90368	0.55	0.586	-28.8513	50.64948
hopeh_wwm_wwg	30.25442	22.57018	1.34	0.185	-14.82135	75.33018
anhwei_wwg_yrw_rt	20.45957	15.63886	1.31	0.195	-10.77339	51.69252
kiangsu_wwg_yrw	14.15592	14.61796	0.97	0.336	-15.03816	43.34999
liaoning_sw_wwg	0	(omitted)				
shantung_wwg	16.49493	23.47743	0.70	0.485	-30.39273	63.38259
chekiang_yrw_rt	25.3277	14.12874	1.79	0.078	-2.889333	53.54474
hupeh_yrw	-9.681794	12.50217	-0.77	0.441	-34.65034	15.28676
kiangsi_yrw_rt_dcr	29.77661	15.98504	1.86	0.067	-2.147721	61.70093
fukien_rt_dcr	0	(omitted)				
szechwan_szr	25.45335	17.28391	1.47	0.146	-9.065008	59.9717
kwangsi_rt_dcr	8.785334	11.41159	0.77	0.444	-14.00518	31.57585
kwangtung_dcr	0	(omitted)				
kweichow_swr	0	(omitted)				
yunnan_swr	-2.302998	3.357201	-0.69	0.495	-9.007792	4.401796

Table A-1 (Continued)

yr1929_01_12	-27.88384	16.31354	-1.71	0.092	-60.46423	4.696552
yr1929_01_1930_01	-79.56145	20.20933	-3.94	0.000	-119.9223	-39.20064
yr1929_02_1930_01	0	(omitted)				
yr1929_10_1930_09	-24.22716	15.98056	-1.52	0.134	-56.14254	7.688226
yr1929_10_1930_10	0	(omitted)				
yr1929_11_1930_10	0	(omitted)				
yr1929_12_1930_12	0	(omitted)				
yr1930_01_12	-37.22498	18.87762	-1.97	0.053	-74.92619	.4762357
yr1930_01_1931_02	-48.15067	25.12292	-1.92	0.060	-98.3246	2.023262
yr1930_02_1931_01	3.893253	24.7132	0.16	0.875	-45.46242	53.24892
yr1930_02_1931_02	0	(omitted)				
yr1930_10_1931_09	-15.98579	17.34488	-0.92	0.360	-50.6259	18.65432
yr1930_10_1931_10	-65.07452	20.44907	-3.18	0.002	-105.9141	-24.2349
yr1930_10_1931_11	-35.3594	18.2998	-1.93	0.058	-71.90661	1.187822
yr1930_11_1931_10	-31.6767	18.39518	-1.72	0.090	-68.41442	5.061012
yr1931_01_12	-26.54241	16.978	-1.56	0.123	-60.44981	7.364985
yr1931_01_1932_01	-60.39954	25.48493	-2.37	0.021	-111.2965	-9.502622
yr1931_02_1932_02	-50.71756	15.368	-3.30	0.002	-81.40958	-20.02553
yr1931_06_1932_05	0	(omitted)				
yr1931_07_1932_06	.326201	25.67444	0.01	0.990	-50.94919	51.60159
yr1931_07_1932_07	0	(omitted)				
yr1931_08_1932_08	-22.19128	15.66555	-1.42	0.161	-53.47754	9.094984
yr1931_09_1932_09	-32.28245	20.33532	-1.59	0.117	-72.89489	8.329991
yr1931_10_1932_09	-33.09663	9.870356	-3.35	0.001	-52.80909	-13.38416
yr1931_11_1932_10	0	(omitted)				
yr1931_11_1932_11	-54.13025	22.18849	-2.44	0.017	-98.44372	-9.81678
yr1931_12_1932_12	-36.64816	20.20758	-1.81	0.074	-77.00548	3.709168
yr1932_01_12	-33.43923	18.27031	-1.83	0.072	-69.92756	3.049108
yr1932_01_1933_01	0	(omitted)				
yr1932_02_1933_01	0	(omitted)				
yr1932_02_1933_02	-45.85716	20.68216	-2.22	0.030	-87.16228	-4.552034
yr1932_03_1933_02	0	(omitted)				
yr1932_05_1933_05	-23.18271	20.19969	-1.15	0.255	-63.52428	17.15886
yr1932_06_1933_05	0	(omitted)				
yr1932_10_1933_09	-27.27358	10.13321	-2.69	0.009	-47.51099	-7.036166
_cons	39.47469	17.30125	2.28	0.026	4.92171	74.02767

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     5.52
         Prob > chi2  =   0.0188
```

Stepwise Selection

stepwise, pr(.20): regress ratio_avg_to_normal pct_crop_area_irri sold_immediately_after_harvest all_farms_manequiv_per_farm all_farms_ind_doublecropping size_crop_hectare_area_mean num_parcels_per_farm avg_dist_of_farthest_parcels_km all_farm_fertilizer all_farms_la total_mwd_pfn_in_marketing total_l_cost_yl

Table A-2 Step-wise Selection of 12 Production Variables

```
                      begin with full model
p = 0.9574 >= 0.2000  removing num_parcels_per_farm
p = 0.9040 >= 0.2000  removing all_farms_la
p = 0.8213 >= 0.2000  removing all_farms_manequiv_per_farm
p = 0.6725 >= 0.2000  removing size_crop_hectare_area_mean
p = 0.5082 >= 0.2000  removing sold_immediately_after_harvest
p = 0.2134 >= 0.2000  removing all_farm_fertilizer
p = 0.3022 >= 0.2000  removing total_l_cost_yl
p = 0.2367 >= 0.2000  removing all_farms_ind_doublecropping
```

Source	SS	df	MS
Model	4108.24393	3	1369.41464
Residual	25090.301	137	183.140883
Total	29198.5449	140	208.561035

Number of obs =	141
F(3, 137) =	7.48
Prob > F =	0.0001
R-squared =	0.1407
Adj R-squared =	0.1219
Root MSE =	13.533

ratio_avg_to_normal	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
pct_crop_area_irri	.1180601	.0313635	3.76	0.000	.056041	.1800792
avg_dist_of_farthest_parcels_km	3.18518	2.007047	1.59	0.115	-.7836166	7.153977
total_mwd_pfn_in_marketing	.1133443	.0480681	2.36	0.020	.018293	.2083956
_cons	66.55888	3.504408	18.99	0.000	59.62916	73.48861

Unrestricted Regression with Control Variables:

regress ratio_avg_to_normal pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Table A-3 Unrestricted OLS Regression for Ratio of Average to Normal with 3 Control Variables

```
Linear regression                                      Number of obs =     151
                                                       F( 32,    94) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.6236
                                                       Root MSE      =  11.023
```

ratio_avg_to_normal	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
pct_crop_area_irri	.1038958	.0739631	1.40	0.163	-.0429597	.2507513
avg_dist_of_farthest_parcels_km	2.628855	2.827861	0.93	0.355	-2.98593	8.24364
total_mwd_pfn_in_marketing	.154819	.0672988	2.30	0.024	.0211957	.2884423
spring_wheat	-21.55181	22.63285	-0.95	0.343	-66.48986	23.38624
winter_wheat_millet	-2.451268	15.98957	-0.15	0.878	-34.19892	29.29639
winter_wheat_gaoliang	9.876658	13.58605	0.73	0.469	-17.09876	36.85207
yangtze_rice_wheat	.1697398	8.27384	0.02	0.984	-16.25816	16.59764
szechwan_rice	-3.05227	7.810515	-0.39	0.697	-18.56023	12.45569
double_cropping_rice	5.860416	8.871425	0.66	0.510	-11.75401	23.47484
southwestern_rice	-8.980364	10.48096	-0.86	0.394	-29.79056	11.82984
kansu_sw_wwm	13.36788	25.31042	0.53	0.599	-36.88654	63.62231
ningsia_sw	0	(omitted)				
shansi_sw_wwm	-13.8038	17.59192	-0.78	0.435	-48.73296	21.12537
shensi_sw_wwm_sr	-16.82819	18.97782	-0.89	0.377	-54.5091	20.85272
suiyuan_sw	0	(omitted)				
tsinghai_sw	3.411888	26.29702	0.13	0.897	-48.80147	55.62524

Table A-3 (Continued)

honan_wwm_wwg_yrw	-15.62651	16.50541	-0.95	0.346	-48.39839	17.14536
hopeh_wwm_wwg	-3.597269	17.08517	-0.21	0.834	-37.52026	30.32573
anhwei_wwg_yrw_rt	-9.730781	10.24509	-0.95	0.345	-30.07265	10.61109
kiangsu_wwg_yrw	-4.426737	11.28021	-0.39	0.696	-26.82385	17.97038
liaoning_sw_wwg	0	(omitted)				
shantung_wwg	-25.80408	17.91507	-1.44	0.153	-61.37488	9.766716
chekiang_yrw_rt	-12.75284	7.928252	-1.61	0.111	-28.49457	2.988892
hupeh_yrw	-5.215512	8.776515	-0.59	0.554	-22.64149	12.21046
kiangsi_yrw_rt_dcr	-1.641206	11.29746	-0.15	0.885	-24.07258	20.79017
fukien_rt_dcr	-20.20815	9.53487	-2.12	0.037	-39.13986	-1.276445
szechwan_szr	0	(omitted)				
kwangsi_rt_dcr	-9.58161	9.056042	-1.06	0.293	-27.56259	8.399374
kwangtung_dcr	-9.244816	7.837762	-1.18	0.241	-24.80688	6.317244
kweichow_swr	5.258929	2.578925	2.04	0.044	.1384119	10.37945
yunnan_swr	0	(omitted)				
yr1929_01_12	8.676297	6.673775	1.30	0.197	-4.57464	21.92723
yr1929_01_1930_01	-37.92087	9.372442	-4.05	0.000	-56.53007	-19.31166
yr1929_02_1930_01	-1.266889	10.08616	-0.13	0.900	-21.29319	18.75941
yr1929_10_1930_09	17.4688	7.624653	2.29	0.024	2.329876	32.60773
yr1929_10_1930_10	-1.125482	7.717583	-0.15	0.884	-16.44892	14.19796
yr1929_11_1930_10	0	(omitted)				
yr1929_12_1930_12	0	(omitted)				
yr1930_01_12	5.396897	7.203219	0.75	0.456	-8.905264	19.69906
yr1930_01_1931_02	17.58853	11.75388	1.50	0.138	-5.74907	40.92613
yr1930_02_1931_01	33.65533	19.05064	1.77	0.081	-4.170171	71.48083
yr1930_02_1931_02	25.74834	11.2506	2.29	0.024	3.410001	48.08667
yr1930_10_1931_09	27.1647	8.958759	3.03	0.003	9.376872	44.95252
yr1930_10_1931_10	-18.94724	11.97256	-1.58	0.117	-42.71904	4.824549
yr1930_10_1931_11	20.10511	10.54368	1.91	0.060	-.8296044	41.03983
yr1930_11_1931_10	16.04966	9.267344	1.73	0.087	-2.350869	34.45019
yr1931_01_12	17.11003	7.573205	2.26	0.026	2.073258	32.14681
yr1931_01_1932_01	-4.094176	11.05807	-0.37	0.712	-26.05024	17.86188
yr1931_02_1932_02	-15.5318	7.458111	-2.08	0.040	-30.34006	-.7235497
yr1931_06_1932_05	-17.18285	7.843761	-2.19	0.031	-32.75682	-1.608875
yr1931_07_1932_06	25.54877	10.60839	2.41	0.018	4.485568	46.61197
yr1931_07_1932_07	0	(omitted)				
yr1931_08_1932_08	14.74743	7.150061	2.06	0.042	.5508134	28.94404
yr1931_09_1932_09	19.37233	7.094625	2.73	0.008	5.28579	33.45888
yr1931_10_1932_09	-17.44594	5.237735	-3.33	0.001	-27.84559	-7.046299
yr1931_11_1932_10	0	(omitted)				
yr1931_11_1932_11	-2.999097	7.114923	-0.42	0.674	-17.12594	11.12775
yr1931_12_1932_12	10.43415	7.419662	1.41	0.163	-4.297768	25.16606
yr1932_01_12	3.061033	10.00891	0.31	0.760	-16.8119	22.93397
yr1932_01_1933_01	13.88881	10.5529	1.32	0.191	-7.06423	34.84185
yr1932_02_1933_01	0	(omitted)				
yr1932_02_1933_02	11.29853	9.079811	1.24	0.216	-6.729651	29.32671
yr1932_03_1933_02	.1277144	1.852553	0.07	0.945	-3.550572	3.806001
yr1932_05_1933_05	27.10006	9.064988	2.99	0.004	9.101312	45.0988
yr1932_06_1933_05	-3.863948	9.847764	-0.39	0.696	-23.41691	15.68902
yr1932_10_1933_09	-2.740823	6.463217	-0.42	0.672	-15.57369	10.09205
_cons	67.75711	6.841135	9.90	0.000	54.17388	81.34035

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     1.54
         Prob > chi2  =   0.2140
```

Main 12 Regressions

For Ratio of Average to Normal:

1) Unrestricted OLS Regression with 12 Production Variables

The same code and result is provided at the beginning of Appendix Part I.

2) Restricted regression with Control Variables, Agricultural Areas and Provinces

regress ratio_avg_to_normal pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     0.24
         Prob > chi2  =   0.6261
```

3) Restricted regression with Control Variables, Provinces and Time Span

regress ratio_avg_to_normal pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =    11.93
         Prob > chi2  =   0.0006
```

4) Restricted regression with Control Variables, Agricultural Areas and Time Span

regress ratio_avg_to_normal pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     2.80
         Prob > chi2  =   0.0945
```

Table A-4 Summary of Four Sets Regressions for the Ratio of Average to Normal

Name of Ind. Variables \ Coefficient and P test		Unrestricted OLS		Cont+Agri. Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri. Area + Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
Control Variables	Irri	0.10	0.16	0.13	0.06	0.08	0.32	0.15	0.04
	Dist	2.63	0.36	1.06	0.69	1.15	0.63	2.53	0.35
	Market	0.15	0.02	0.08	0.21	0.16	0.01	0.10	0.09
Agri. Areas	SW	-21.55	0.34	-24.34	0.26			-11.00	0.23
	WWM	-2.45	0.88	0.44	0.98			-1.77	0.81
	WWG	9.88	0.47	0.33	0.98			7.09	0.37
	YRW	0.17	0.98	-10.13	0.22			-0.68	0.93
	SzR	-3.05	0.70	0.00				6.05	0.38
	DCR	5.86	0.51	16.03	0.00			0.92	0.86
	SwR	-8.98	0.39	-1.63	0.66			-0.44	0.93
Prov.	Kansu	13.37	0.60	25.87	0.24	1.13	0.94		
	Ningsia	0.00		0.00		0.00			
	Shansi	-13.80	0.44	4.12	0.79	-14.58	0.10		
	Shensi	-16.83	0.38	7.41	0.65	-23.41	0.15		
	Suiyuan	0.00		0.00		0.00			
	Tsinghai	3.41	0.90	28.85	0.19	-13.30	0.06		
	Honan	-15.63	0.35	5.28	0.72	-6.87	0.28		
	Hopeh	-3.60	0.83	15.03	0.32	6.38	0.54		
	Anhwei	-9.73	0.35	8.69	0.33	-4.89	0.48		
	Kiangsu	-4.43	0.70	10.64	0.26	-0.62	0.91		
	Liaoning	0.00		0.00		0.00			
	Shantung	-25.80	0.15	5.01	0.72	-14.70	0.18		
	Chekiang	-12.75	0.11	-2.58	0.56	-8.00	0.22		
	Hupeh	-5.22	0.55	-4.56	0.62	-6.72	0.30		
	Kiangsi	-1.64	0.89	3.48	0.52	2.37	0.81		
	Fukien	-20.21	0.04	-2.43	0.61	-13.27	0.11		
	Szechwan	0.00		10.95	0.02	0.35	0.95		
	Kwangsi	-9.58	0.29	-14.92	0.03	0.95	0.91		
	Kwangtung	-9.24	0.24	-8.59	0.27	1.41	0.87		
	Kweichow	5.26	0.04	5.29	0.01	0.00	1.00		
	Yunnan	0.00		0.00		-5.03	0.56		

Coefficient and P test / Name of Ind. Variables		Unrestricted OLS		Cont+Agri. Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri. Area + Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
Time Span	2901-2912	8.68	0.20			4.72	0.35	7.47	0.38
	2901-3001	-37.92	0.00			-38.86	0.00	-28.83	0.00
	2902-3001	-1.27	0.90			-5.95	0.39	-9.09	0.28
	2910-3009	17.47	0.02			13.61	0.04	9.26	0.07
	2910-3010	-1.13	0.88			-4.16	0.52	-1.62	0.86
	2911-3010	0.00				0.00		0.00	
	2912-3012	0.00				0.00		0.00	
	3001-3012	5.40	0.46			2.72	0.67	2.84	0.76
	3001-3102	17.59	0.14			15.25	0.15	2.92	0.80
	3002-3101	33.66	0.08			19.07	0.18	14.46	0.19
	3002-3102	25.75	0.02			23.30	0.01	21.17	0.01
	3010-3109	27.16	0.00			24.06	0.00	13.52	0.06
	3010-3110	-18.95	0.12			-23.02	0.01	-22.90	0.02
	3010-3111	20.11	0.06			21.02	0.09	11.40	0.22
	3011-3110	16.05	0.09			14.97	0.10	3.23	0.69
	3101-3112	17.11	0.03			14.04	0.01	13.22	0.10
	3101-3201	-4.09	0.71			-10.09	0.37	-3.82	0.61
	3102-3202	-15.53	0.04			-15.83	0.01	-20.54	0.01
	3106-3205	-17.18	0.03			-19.62	0.00	-16.87	0.07
	3107-3206	25.55	0.02			29.34	0.03	19.08	0.04
	3107-3207	0.00				0.00		0.00	
	3108-3208	14.75	0.04			12.93	0.03	8.86	0.25
	3109-3209	19.37	0.01			15.92	0.01	9.58	0.06
	3110-3209	-17.45	0.00			-15.69	0.01	-17.33	0.05
	3111-3210	0.00				0.00		3.45	0.71
	3111-3211	-3.00	0.67			-6.57	0.28	-12.75	0.01
	3112-3212	10.43	0.16			7.46	0.24	1.92	0.73
	3201-3212	3.06	0.76			0.03	1.00	3.36	0.60
	3201-3301	13.89	0.19			10.68	0.21	13.24	0.05
	3202-3301	0.00				0.00		0.00	
	3202-3302	11.30	0.22			9.10	0.25	-3.28	0.66
	3203-3302	0.13	0.95			0.35	0.84	4.40	0.35
	3205-3305	27.10	0.00			23.48	0.00	21.02	0.02

Coefficient and P test / Name of Ind. Variables		Unrestricted OLS		Cont+Agri. Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri. Area + Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
	3206-3305	-3.86	0.70			-10.06	0.19	-5.34	0.55
	3210-3309	-2.74	0.67			-2.70	0.65	2.07	0.77
Cons.		67.76	0.00	66.16	0.00	70.51	0.00	60.59	0.00

For Ratio of Average to Best:

1) Unrestricted OLS Regression with Control Variables

regress ratio_avg_to_best pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:
hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_best

         chi2(1)      =     3.74
         Prob > chi2  =   0.0531
```

2) Restricted regression with Control Variables, Agricultural Areas and Provinces

regress ratio_avg_to_best pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr, r

Test for heteroskedasticity:
hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of ratio_avg_to_best

        chi2(1)      =     5.76
        Prob > chi2  =   0.0164
```

3) Restricted regression with Control Variables, Provinces and Time Span

regress ratio_avg_to_best pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of ratio_avg_to_best

        chi2(1)      =     0.00
        Prob > chi2  =   0.9714
```

4) Restricted regression with Control Variables, Agricultural Areas and Time Span

regress ratio_avg_to_best pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_best

         chi2(1)      =     0.64
         Prob > chi2  =   0.4249
```

Table A-5 Summary of Four Sets Regressions for the Ratio of Average to Best

Name of Ind. Variables \ Coefficient and P test		Unrestricted OLS		Cont+Agri. Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri. Area+ Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
Control Variables	Irri	0.09	0.13	0.12	0.05	0.07	0.27	0.13	0.05
	Dist	1.79	0.40	0.84	0.71	0.56	0.76	1.41	0.55
	Market	0.17	0.01	0.11	0.06	0.17	0.00	0.11	0.03
Agri. Areas	SW	-23.47	0.26	-32.21	0.09			-19.41	0.02
	WWM	-5.37	0.73	-8.28	0.57			-10.12	0.13
	WWG	5.49	0.69	-8.20	0.55			-4.27	0.55
	YRW	-2.51	0.76	-14.41	0.06			-6.65	0.29
	SzR	-13.96	0.13	0.00				1.81	0.80
	DCR	-10.19	0.21	4.45	0.06			-2.27	0.61
	SwR	-23.86	0.03	-8.18	0.03			-4.21	0.26
Prov.	Kansu	-5.72	0.80	18.28	0.31	-20.15	0.10		
	Ningsia	0.00		0.00		0.00			
	Shansi	-25.52	0.18	0.96	0.95	-29.02	0.00		
	Shensi	-22.24	0.28	10.24	0.50	-31.08	0.07		
	Suiyuan	0.00		0.00		0.00			
	Tsinghai	-9.61	0.70	25.03	0.19	-28.50	0.00		
	Honan	-28.92	0.11	1.56	0.91	-24.10	0.00		
	Hopeh	-17.88	0.33	9.93	0.48	-11.78	0.23		
	Anhwei	-24.42	0.02	3.29	0.71	-21.69	0.01		
	Kiangsu	-13.59	0.28	7.96	0.39	-12.42	0.08		
	Liaoning	0.00		0.00		0.00			
	Shantung	-37.63	0.05	1.25	0.92	-30.51	0.01		
	Chekiang	-16.06	0.07	-3.32	0.45	-11.95	0.10		
	Hupeh	-9.05	0.31	-1.95	0.81	-13.00	0.02		
	Kiangsi	-16.26	0.15	-2.25	0.62	-11.81	0.21		
	Fukien	-21.87	0.02	-1.60	0.73	-21.06	0.01		
	Szechwan	0.00		3.42	0.54	-10.38	0.17		
	Kwangsi	-6.86	0.56	-7.76	0.37	-12.06	0.27		
	Kwangtung	-9.98	0.24	-6.07	0.38	-14.36	0.10		
	Kweichow	2.32	0.40	2.48	0.26	-17.30	0.06		
	Yunnan	0.00		0.00		-19.44	0.03		
Time	2901-2912	11.99	0.13			7.77	0.23	5.09	0.60

Name of Ind. Variables \ Coefficient and P test		Unrestricted OLS		Cont+Agri. Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri. Area+ Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
Span	2901-3001	-25.35	0.01			-26.70	0.00	-23.07	0.01
	2902-3001	-7.44	0.51			-14.26	0.06	-14.21	0.11
	2910-3009	21.53	0.01			18.04	0.01	11.26	0.09
	2910-3010	0.47	0.96			-2.87	0.71	-4.55	0.63
	2911-3010	0.00				0.00		0.00	
	2912-3012	0.00				0.00		0.00	
	3001-3012	10.81	0.21			7.76	0.32	3.01	0.77
	3001-3102	19.55	0.08			16.94	0.08	0.59	0.95
	3002-3101	31.60	0.10			17.24	0.28	14.26	0.20
	3002-3102	32.97	0.00			24.86	0.00	15.43	0.10
	3010-3109	31.57	0.00			28.35	0.00	13.40	0.11
	3010-3110	-11.22	0.37			-17.45	0.05	-14.39	0.15
	3010-3111	14.02	0.16			14.50	0.20	2.87	0.77
	3011-3110	21.88	0.04			20.50	0.06	5.90	0.58
	3101-3112	21.29	0.01			18.08	0.01	11.32	0.22
	3101-3201	1.29	0.90			-4.55	0.63	-5.13	0.52
	3102-3202	-6.51	0.44			-7.05	0.32	-17.39	0.04
	3106-3205	-7.42	0.40			-10.24	0.17	-11.63	0.23
	3107-3206	34.22	0.00			37.38	0.02	28.36	0.01
	3107-3207	0.00				0.00		0.00	
	3108-3208	18.02	0.03			17.15	0.02	8.91	0.36
	3109-3209	15.85	0.06			12.67	0.07	4.20	0.53
	3110-3209	-10.64	0.02			-9.26	0.04	-9.95	0.27
	3111-3210	0.00				0.00		3.29	0.71
	3111-3211	1.89	0.82			-1.39	0.84	-9.73	0.14
	3112-3212	11.20	0.19			8.44	0.24	0.81	0.91
	3201-3212	12.20	0.25			8.43	0.35	1.23	0.87
	3201-3301	17.84	0.11			13.18	0.14	5.08	0.52
	3202-3301	0.00				0.00		0.00	
	3202-3302	16.50	0.10			14.02	0.12	-2.42	0.78
	3203-3302	-1.07	0.63			-1.02	0.62	4.37	0.49
	3205-3305	38.73	0.00			34.21	0.00	22.70	0.02
	3206-3305	2.41	0.82			-4.14	0.63	-9.98	0.26

Coefficient and P test / Name of Ind. Variables		Unrestricted OLS		Cont+Agri. Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri. Area+ Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
	3210-3309	-3.66	0.65			-4.16	0.57	-0.84	0.91
Cons.		68.05	0.00	65.33	0.00	70.38	0.00	60.69	0.00

For Average Yield:

1) Unrestricted OLS Regression with Control Variables

regress average_yield pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of average_yield

         chi2(1)      =     0.01
         Prob > chi2  =   0.9200
```

2) Restricted regression with Control Variables, Agricultural Areas and Provinces

regress average_yield pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of average_yield

        chi2(1)      =     3.78
        Prob > chi2  =   0.0517
```

3) Restricted regression with Control Variables, Provinces and Time Span

regress average_yield pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
        Ho: Constant variance
        Variables: fitted values of average_yield

        chi2(1)      =     6.94
        Prob > chi2  =   0.0084
```

4) Restricted regression with Control Variables, Agricultural Areas and Time Span

regress average_yield pct_crop_area_irri avg_dist_of_farthest_parcels_km total_mwd_pfn_in_marketing spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of average_yield

         chi2(1)      =     0.35
         Prob > chi2  =   0.5547
```

Table A-6 Summary of Four Sets Regressions for Average Yield

Name of Ind. Variables	Coefficient and P test	Unrestricted OLS		Cont+Agri Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri Area+ Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
Control Variables	Irri	0.08	0.42	0.15	0.06	0.04	0.72	0.14	0.11
	Dist	5.00	0.18	3.13	0.31	3.18	0.30	4.68	0.16
	Market	0.17	0.02	0.08	0.27	0.17	0.01	0.09	0.18
Agri. Areas	SW	-23.73	0.45	-21.53	0.44			-14.78	0.22
	WWM	1.82	0.92	9.77	0.60			-1.06	0.91
	WWG	15.10	0.34	10.00	0.55			8.12	0.41
	YRW	1.93	0.85	-8.08	0.36			-0.20	0.98
	SzR	-8.05	0.33	0.00				-0.27	0.98
	DCR	-1.02	0.93	2.70	0.38			-4.93	0.44
	SwR	-3.43	0.77	-9.36	0.09			1.67	0.78
Prov.	Kansu	18.37	0.57	18.76	0.51	6.70	0.74		
	Ningsia	0.00		0.00		0.00			
	Shansi	-18.44	0.35	-11.99	0.51	-15.32	0.14		
	Shensi	-17.53	0.43	-4.04	0.84	-21.98	0.31		
	Suiyuan	0.00		0.00		0.00			
	Tsinghai	1.85	0.96	13.36	0.64	-16.54	0.03		
	Honan	-14.78	0.41	-7.59	0.66	-0.92	0.89		
	Hopeh	-6.95	0.71	-1.24	0.94	8.57	0.49		
	Anhwei	-7.27	0.54	-0.69	0.95	0.92	0.91		
	Kiangsu	-1.39	0.91	1.95	0.85	5.61	0.29		
	Liaoning	0.00		0.00		0.00			
	Shantung	-32.27	0.11	-8.28	0.61	-16.38	0.21		
	Chekiang	-11.22	0.27	-7.14	0.28	-5.35	0.55		
	Hupeh	-16.19	0.13	8.05	0.39	-17.02	0.04		
	Kiangsi	6.50	0.62	-2.35	0.73	12.54	0.26		
	Fukien	-9.31	0.40	-1.74	0.79	-2.90	0.74		
	Szechwan	0.00		-1.51	0.80	-3.78	0.57		
	Kwangsi	-3.03	0.78	-15.90	0.09	2.88	0.79		
	Kwangtung	-1.73	0.84	-6.21	0.52	4.51	0.63		
	Kweichow	10.37	0.00	10.81	0.00	12.37	0.21		
	Yunnan	0.00		0.00		2.33	0.81		
Time	2901-2912	-4.55	0.50			-10.18	0.03	-4.26	0.63

Name of Ind. Variables \ Coefficient and P test		Unrestricted OLS		Cont+Agri Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri Area+ Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
Span	2901-3001	-67.39	0.00			-69.77	0.00	-55.72	0.00
	2902-3001	-18.49	0.14			-22.72	0.02	-24.00	0.01
	2910-3009	5.34	0.59			0.36	0.97	-1.53	0.71
	2910-3010	-20.30	0.02			-24.64	0.00	-17.36	0.09
	2911-3010	0.00				0.00		0.00	
	2912-3012	0.00				0.00		0.00	
	3001-3012	-9.71	0.22			-13.74	0.05	-9.54	0.37
	3001-3102	13.25	0.24			10.36	0.29	-2.60	0.81
	3002-3101	15.65	0.56			-3.87	0.84	-1.35	0.92
	3002-3102	3.40	0.80			-3.64	0.68	7.02	0.39
	3010-3109	10.47	0.28			6.51	0.42	-4.03	0.58
	3010-3110	-30.51	0.05			-34.52	0.01	-30.44	0.01
	3010-3111	8.18	0.47			9.66	0.50	1.25	0.91
	3011-3110	4.78	0.67			3.48	0.77	-7.72	0.47
	3101-3112	0.44	0.96			-3.20	0.57	-1.32	0.88
	3101-3201	-7.10	0.68			-15.06	0.40	-2.70	0.72
	3102-3202	-39.60	0.00			-40.81	0.00	-38.63	0.00
	3106-3205	-43.05	0.00			-46.77	0.00	-38.87	0.00
	3107-3206	8.58	0.52			13.39	0.46	7.14	0.47
	3107-3207	0.00				0.00		0.00	
	3108-3208	-0.89	0.90			-3.30	0.58	-1.28	0.84
	3109-3209	17.37	0.05			13.10	0.12	8.29	0.04
	3110-3209	8.06	0.23			10.72	0.13	-1.89	0.85
	3111-3210	0.00				0.00		-5.35	0.62
	3111-3211	-17.26	0.06			-21.67	0.01	-26.29	0.00
	3112-3212	-7.32	0.44			-11.17	0.21	-14.52	0.00
	3201-3212	-16.42	0.17			-21.40	0.04	-9.86	0.12
	3201-3301	6.29	0.61			0.91	0.93	11.60	0.09
	3202-3301	0.00				0.00		0.00	
	3202-3302	-1.99	0.84			-4.75	0.58	-17.64	0.02
	3203-3302	-14.87	0.00			-14.77	0.00	-11.04	0.00
	3205-3305	4.56	0.70			-0.38	0.97	1.29	0.90
	3206-3305	-17.59	0.17			-26.36	0.01	-14.61	0.17

Name of Ind. Variables \ Coefficient and P test		Unrestricted OLS		Cont+Agri Area+ Prov.		Cont+Prov. + Time Span		Cont + Agri Area+ Time Span	
		Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|	Coef.	P>|t|
	3210-3309	-16.20	0.01			-16.65	0.00	-7.07	0.34
Cons.		99.11	0.00	89.00	0.00	103.12	0.00	91.39	0.00

Four Regressions with Time Span

For Ratio of Average to Normal:

1) Restricted Regression with Provinces and Time Span

regress ratio_avg_to_normal kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     2.69
         Prob > chi2  =   0.1010
```

TableA-7 Coefficient and Covariance of Time Span and Provinces for the Ratio of Average to Normal (1)

Province / Coefficient / Year, Month		Kansu sw wwm	Ningsia sw	Shansi sw wwm	Shensi sw wwm sr	Suiyuan sw	Tsinghai sw	Honan wwm wwg yrw
Coefficient		-4.40	6.51	-15.75	-21.51	2.44	-10.92	-10.48
2901-2912	6.00	1.60	12.51	$\boxed{-9.75}$	-15.51	$\boxed{8.44}$	-4.92	-4.48
2901-3001	-32.73	-37.13	-26.22	-48.48	-54.24	-30.29	-43.65	-43.21
2902-3001	3.08	-1.33	9.58	-12.67	-18.43	5.52	-7.84	-7.40
2910-3009	13.02	8.61	19.52	-2.73	-8.49	15.46	2.10	2.54
2910-3010	9.58	5.18	16.09	-6.16	-11.93	12.02	-1.33	-0.90
2911-3010	5.95	1.55	12.45	-9.80	-15.56	8.39	-4.97	-4.53
2912-3012	26.78	22.38	33.29	11.04	5.27	29.22	15.87	16.30
3001-3012	9.21	4.81	15.72	$\boxed{-6.53}$	$\boxed{-12.30}$	11.65	-1.70	$\boxed{-1.27}$
3001-3102	14.75	10.35	21.25	-1.00	-6.76	17.19	3.83	4.27
3002-3101	16.50	12.10	23.01	0.75	$\boxed{-5.01}$	18.94	5.58	6.02
3002-3102	19.10	14.70	25.61	3.35	-2.41	21.54	8.18	8.62
3010-3109	29.42	25.02	35.93	13.68	$\boxed{7.91}$	31.86	18.50	18.94
3010-3110	-27.28	-31.69	-20.78	-43.03	-48.79	-24.84	-38.20	-37.76
3010-3111	17.97	13.56	24.47	$\boxed{2.22}$	$\boxed{-3.54}$	20.41	7.05	7.49
3011-3110	14.57	10.17	21.08	-1.17	$\boxed{-6.94}$	17.01	3.65	4.09
3101-3112	16.06	$\boxed{11.66}$	22.56	$\boxed{0.31}$	$\boxed{-5.45}$	18.50	$\boxed{5.14}$	$\boxed{5.58}$
3101-3201	-3.99	$\boxed{-8.40}$	2.51	-19.74	-25.51	-1.56	-14.91	-14.48
3102-3202	-2.34	-6.75	4.16	-18.09	-23.85	0.09	-13.26	$\boxed{-12.83}$
3106-3205	-7.32	-11.72	-0.81	-23.06	-28.83	-4.88	-18.23	-17.80
3107-3206	22.30	17.90	28.81	6.55	$\boxed{0.79}$	24.74	11.38	11.82
3107-3207	12.67	8.27	19.18	-3.08	-8.84	15.11	1.75	2.19
3108-3208	14.15	9.75	20.66	-1.59	-7.36	16.59	3.23	$\boxed{3.67}$
3109-3209	16.02	11.61	22.52	0.27	-5.49	18.46	5.10	5.54
3110-3209	-23.28	-27.69	-16.78	-39.03	-44.79	-20.85	-34.20	-33.77
3111-3210	-13.58	-17.99	-7.08	-29.33	-35.09	-11.15	-24.50	-24.07
3111-3211	-6.18	-10.59	0.32	-21.93	-27.69	-3.74	-17.10	-16.66
3112-3212	7.52	3.11	14.02	-8.23	-13.99	9.96	-3.40	-2.96
3201-3212	10.08	$\boxed{5.68}$	$\boxed{16.59}$	$\boxed{-5.66}$	-11.43	12.52	-0.84	$\boxed{-0.40}$
3201-3301	21.44	17.03	27.94	5.69	-0.07	23.87	10.52	10.95
3202-3301	13.59	9.19	20.10	-2.16	-7.92	16.03	2.67	3.11

Province Coefficient / Year, Month		Kansu sw wwm	Ningsia sw	Shansi sw wwm	Shensi sw wwm sr	Suiyuan sw	Tsinghai sw	Honan wwm wwg yrw
Coefficient		-4.40	6.51	-15.75	-21.51	2.44	-10.92	-10.48
3202-3302	5.85	1.45	12.35	-9.90	-15.66	8.29	-5.07	-4.63
3203-3302	3.96	-0.44	10.47	-11.78	-17.55	6.40	-6.95	-6.52
3205-3305	32.12	27.72	38.63	16.38	10.61	34.56	21.20	21.64
3206-3305	-4.99	-9.40	1.51	-20.74	-26.50	-2.56	-15.91	-15.48
3210-3309	2.42	-1.98	8.93	-13.33	-19.09	4.86	-8.50	-8.06

TableA-7 Coefficient and Covariance of Time Span and Provinces for the Ratio of Average to Normal (2)

Province Coefficient / Year, Month		Hopeh wwm wwg	Anhwei wwg yrw rt	Kiangsu wwg yrw	Liaoning sw wwg	Shantung wwg	Che -kiang yrw rt	Hupeh yrw
Coefficient		3.22	-9.83	-10.19	-21.93	-12.46	-5.13	3.97
2901-2912	6.00	$\boxed{9.22}$	$\boxed{-3.83}$	$\boxed{-4.19}$	-15.92	$\boxed{-6.46}$	$\boxed{0.87}$	$\boxed{9.97}$
2901-3001	-32.73	$\boxed{-29.51}$	-42.56	-42.92	-54.65	-45.19	-37.86	-28.76
2902-3001	3.08	6.30	-6.76	-7.12	-18.85	-9.38	$\boxed{-2.05}$	7.05
2910-3009	13.02	16.24	3.18	2.82	-8.91	0.56	$\boxed{7.89}$	16.99
2910-3010	9.58	12.80	-0.25	$\boxed{-0.61}$	-12.34	-2.88	4.46	13.56
2911-3010	5.95	9.17	-3.88	-4.25	-15.98	$\boxed{-6.51}$	0.82	9.92
2912-3012	26.78	30.00	16.95	$\boxed{16.59}$	4.86	14.32	21.66	30.76
3001-3012	9.21	$\boxed{12.43}$	$\boxed{-0.62}$	$\boxed{-0.98}$	$\boxed{-12.71}$	$\boxed{-3.24}$	4.09	$\boxed{13.19}$
3001-3102	14.75	17.97	4.92	4.55	-7.18	$\boxed{2.29}$	9.62	18.72
3002-3101	16.50	19.72	6.67	6.31	-5.43	4.04	11.37	20.47
3002-3102	19.10	22.32	9.27	8.91	-2.82	6.64	13.97	23.07
3010-3109	29.42	32.64	19.59	19.23	7.50	$\boxed{16.96}$	24.30	33.40
3010-3110	-27.28	-24.06	-37.12	-37.48	-49.21	-39.74	$\boxed{-32.41}$	-23.31
3010-3111	17.97	21.19	8.13	7.77	-3.96	5.51	12.84	21.94
3011-3110	14.57	17.79	4.74	4.38	-7.35	$\boxed{2.11}$	$\boxed{9.45}$	18.55
3101-3112	16.06	$\boxed{19.28}$	$\boxed{6.22}$	5.86	-5.87	$\boxed{3.60}$	$\boxed{10.93}$	20.03
3101-3201	-3.99	-0.78	-13.83	-14.19	-25.92	-16.45	$\boxed{-9.12}$	-0.02
3102-3202	-2.34	0.87	-12.18	-12.54	-24.27	-14.80	-7.47	$\boxed{1.63}$
3106-3205	-7.32	-4.10	-17.15	$\boxed{-17.51}$	-29.24	-19.78	-12.44	-3.34

Year, Month \ Province	Coefficient	Hopeh wwm wwg	Anhwei wwg yrw rt	Kiangsu wwg yrw	Liaoning sw wwg	Shantung wwg	Che-kiang yrw rt	Hupeh yrw
Coefficient		3.22	-9.83	-10.19	-21.93	-12.46	-5.13	3.97
3107-3206	22.30	25.52	12.47	12.10	0.37	9.84	17.17	26.27
3107-3207	12.67	15.89	2.84	2.48	-9.25	0.21	7.54	16.64
3108-3208	14.15	17.37	4.32	3.96	-7.77	1.69	$\boxed{9.03}$	18.13
3109-3209	16.02	19.24	6.18	5.82	-5.91	3.56	$\boxed{10.89}$	19.99
3110-3209	-23.28	-20.07	-33.12	-33.48	-45.21	-35.74	-28.41	$\boxed{-19.31}$
3111-3210	-13.58	-10.37	-23.42	-23.78	-35.51	-26.04	-18.71	$\boxed{-9.61}$
3111-3211	-6.18	-2.96	-16.02	-16.38	-28.11	-18.64	$\boxed{-11.31}$	-2.21
3112-3212	7.52	10.74	-2.32	-2.68	-14.41	-4.94	$\boxed{2.39}$	11.49
3201-3212	10.08	13.30	$\boxed{0.25}$	$\boxed{-0.11}$	-11.84	-2.38	4.96	14.06
3201-3301	21.44	24.65	11.60	11.24	-0.49	8.98	16.31	25.41
3202-3301	13.59	16.81	3.76	3.39	-8.34	1.13	8.46	17.56
3202-3302	5.85	9.07	-3.98	-4.35	-16.08	$\boxed{-6.61}$	0.72	9.82
3203-3302	3.96	7.18	-5.87	-6.23	-17.96	-8.50	-1.16	7.94
3205-3305	32.12	35.34	$\boxed{22.29}$	21.93	10.20	19.66	27.00	36.10
3206-3305	-4.99	-1.78	$\boxed{-14.83}$	-15.19	-26.92	-17.45	-10.12	-1.02
3210-3309	2.42	5.64	-7.41	$\boxed{-7.78}$	-19.51	-10.04	-2.71	6.39

TableA-7 Coefficient and Covariance of Time Span and Provinces for the Ratio of Average to Normal (3)

Year, Month \ Province	Coefficient	Kiangsi yrw rt dcr	Fukien rt dcr	Szechwan szr	Kwangsi rt dcr	Kwang-tung dcr	Kweichow swr	Yunnan swr
Coefficient		-1.40	1.55	3.87	-4.82	-4.39	-1.68	-5.26
2901-2912	6.00	4.60	7.55	$\boxed{9.87}$	1.18	1.62	4.33	0.74
2901-3001	-32.73	-34.13	-31.18	-28.86	-37.55	-37.11	-34.40	-37.99
2902-3001	3.08	1.68	$\boxed{4.63}$	6.95	-1.74	-1.31	1.40	-2.18
2910-3009	13.02	11.62	14.57	16.89	8.20	8.63	11.34	7.76
2910-3010	9.58	8.19	11.14	13.46	4.76	5.20	7.91	4.33
2911-3010	5.95	4.55	7.50	9.82	1.13	1.56	4.27	0.69
2912-3012	26.78	25.39	28.34	30.66	21.96	22.40	25.11	21.53
3001-3012	9.21	7.82	$\boxed{10.77}$	$\boxed{13.09}$	4.39	4.83	7.54	3.96
3001-3102	14.75	13.35	16.30	18.62	9.93	10.36	13.07	9.49

Province / Coefficient / Year, Month		Kiangsi yrw rt dcr	Fukien rt dcr	Szechwan szr	Kwangsi rt dcr	Kwang-tung dcr	Kweichow swr	Yunnan swr
Coefficient		-1.40	1.55	3.87	-4.82	-4.39	-1.68	-5.26
3002-3101	16.50	15.10	18.05	20.37	11.68	12.11	14.82	11.24
3002-3102	19.10	17.70	$\boxed{20.65}$	22.97	14.28	$\boxed{14.72}$	17.43	13.84
3010-3109	29.42	28.02	30.98	33.29	24.60	25.04	27.75	24.16
3010-3110	-27.28	-28.68	-25.73	-23.41	-32.10	-31.67	-28.96	-32.54
3010-3111	17.97	16.57	19.52	21.84	13.15	13.58	16.29	12.71
3011-3110	14.57	13.17	16.13	18.44	9.75	10.19	12.90	9.31
3101-3112	16.06	14.66	17.61	$\boxed{19.93}$	11.24	11.67	14.38	10.80
3101-3201	-3.99	-5.39	-2.44	-0.12	-8.82	-8.38	-5.67	-9.25
3102-3202	-2.34	-3.74	-0.79	1.53	-7.17	-6.73	-4.02	-7.60
3106-3205	-7.32	-8.71	-5.76	-3.44	-12.14	-11.70	-8.99	-12.57
3107-3206	22.30	20.90	23.85	$\boxed{26.17}$	17.48	17.91	20.62	17.04
3107-3207	12.67	11.27	$\boxed{14.22}$	16.54	7.85	8.28	11.00	7.41
3108-3208	14.15	12.75	$\boxed{15.71}$	18.02	9.33	9.77	12.48	8.89
3109-3209	16.02	14.62	17.57	19.89	11.20	11.63	14.34	10.76
3110-3209	-23.28	-24.68	-21.73	-19.41	-28.10	-27.67	-24.96	-28.54
3111-3210	-13.58	-14.98	-12.03	-9.71	-18.40	-17.97	-15.26	-18.84
3111-3211	-6.18	-7.58	-4.63	-2.31	-11.00	-10.57	-7.86	-11.44
3112-3212	7.52	6.12	9.07	11.39	2.70	3.13	5.84	2.26
3201-3212	10.08	$\boxed{8.69}$	11.64	13.96	$\boxed{5.26}$	$\boxed{5.70}$	$\boxed{8.41}$	$\boxed{4.82}$
3201-3301	21.44	20.04	22.99	25.31	16.61	$\boxed{17.05}$	19.76	16.18
3202-3301	13.59	12.19	15.14	17.46	8.77	9.20	11.91	8.33
3202-3302	5.85	4.45	7.40	9.72	1.03	1.46	4.17	0.59
3203-3302	3.96	2.57	5.52	7.84	-0.86	-0.42	2.29	-1.30
3205-3305	32.12	30.72	33.68	35.99	27.30	27.74	30.45	26.86
3206-3305	-4.99	$\boxed{-6.39}$	-3.44	-1.12	-9.81	-9.38	-6.67	-10.25
3210-3309	2.42	1.02	3.97	6.29	-2.40	-1.97	0.74	-2.84

2) **Restricted Regression with Agricultural Areas and Time Span**

regress ratio_avg_to_normal spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     1.16
         Prob > chi2  =   0.2819
```

Table A-8 Coefficient and Covariance of Time Span and Agricultural Areas for the Ratio of Average to Normal

Agricultural Area / Coefficient / Year, Month		Spring wheat	Winter Wheat millet	Winter Wheat gaoliang	Yangtze Rice wheat	Szechwan rice	Double Cropping rice	South -western rice
Coefficient		-8.41	-14.93	-5.59	-8.08	3.35	-1.87	-1.68
2901-2912	7.15	-1.26	-7.77	1.56	-0.93	10.51	5.28	5.48
2901-3001	-23.74	-32.15	-38.67	-29.33	-31.82	-20.39	-25.61	-25.42
2902-3001	5.51	-2.90	-9.42	-0.08	-2.57	8.86	3.64	3.83
2910-3009	8.07	-0.34	-6.86	2.48	-0.01	11.42	6.20	6.39
2910-3010	7.65	-0.76	-7.28	2.06	-0.43	11.00	5.78	5.97
2911-3010	-0.74	-9.15	-15.67	-6.33	-8.82	2.61	-2.61	-2.42
2912-3012	24.85	16.44	9.92	19.26	16.77	28.20	22.98	23.17
3001-3012	8.86	0.45	-6.07	3.27	0.78	12.21	6.99	7.18
3001-3102	8.06	-0.35	-6.87	2.47	-0.02	11.41	6.19	6.38
3002-3101	3.58	-4.83	-11.35	-2.01	-4.50	6.93	1.71	1.90
3002-3102	18.75	10.34	3.82	13.16	10.67	22.10	16.87	17.07
3010-3109	13.74	5.33	-1.19	8.14	5.66	17.09	11.86	12.06
3010-3110	-24.15	-32.56	-39.08	-29.74	-32.23	-20.80	-26.02	-25.83
3010-3111	14.45	6.04	-0.48	8.86	6.37	17.80	12.57	12.77
3011-3110	8.29	-0.12	-6.64	2.70	0.21	11.64	6.42	6.61
3101-3112	17.66	9.25	2.74	12.07	9.58	21.02	15.79	15.99
3101-3201	-4.38	-12.79	-19.30	-9.97	-12.46	-1.02	-6.25	-6.05
3102-3202	5.65	-2.76	-9.28	0.06	-2.43	9.01	3.78	3.97
3106-3205	-9.25	-17.66	-24.18	-14.84	-17.33	-5.90	-11.12	-10.93
3107-3206	19.45	11.04	4.52	13.86	11.37	22.80	17.57	17.77
3107-3207	16.27	7.87	1.35	10.68	8.20	19.63	14.40	14.60
3108-3208	10.53	2.12	-4.40	4.94	2.45	13.88	8.65	8.85
3109-3209	11.07	2.66	-3.86	5.48	2.99	14.42	9.20	9.39
3110-3209	-11.05	-19.46	-25.98	-16.64	-19.13	-7.70	-12.92	-12.73
3111-3210	-1.35	-9.76	-16.28	-6.94	-9.43	2.00	-3.22	-3.03
3111-3211	-11.13	-19.54	-26.06	-16.72	-19.21	-7.78	-13.00	-12.81
3112-3212	2.57	-5.84	-12.36	-3.02	-5.51	5.92	0.70	0.89
3201-3212	8.14	-0.27	-6.78	2.55	0.06	11.50	6.27	6.46
3201-3301	19.10	10.69	4.17	13.51	11.02	22.46	17.23	17.42
3202-3301	13.77	5.36	-1.16	8.18	5.69	17.12	11.90	12.09
3202-3302	-0.84	-9.25	-15.77	-6.43	-8.92	2.51	-2.71	-2.52

Agricultural Area / Coefficient / Year, Month		Spring wheat	Winter Wheat millet	Winter Wheat gaoliang	Yangtze Rice wheat	Szechwan rice	Double Cropping rice	South -western rice
Coefficient		-8.41	-14.93	-5.59	-8.08	3.35	-1.87	-1.68
3203-3302	4.14	-4.27	-10.78	-1.45	-3.94	7.50	2.27	2.46
3205-3305	30.55	22.14	15.62	24.96	22.47	33.90	28.68	28.87
3206-3305	-2.35	-10.76	-17.28	-7.94	-10.43	1.00	-4.22	-4.03
3210-3309	0.36	-8.05	-14.57	-5.23	-7.72	3.71	-1.51	-1.32

For Ratio of Average to Best:

1) Restricted Regression with Provinces and Time Span

regress ratio_avg_to_best kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_best

         chi2(1)      =     0.44
         Prob > chi2  =   0.5088
```

Table A-9 Coefficient and Covariance of Time Span and Provinces for the Ratio of Average to Best (1)

Province Coefficient / Year, Month Coefficient		Kansu sw wwm	Ningsia sw	Shansi sw wwm	Shensi sw wwm sr	Suiyuan sw	Tsinghai sw	Honan wwm wwg yrw
		-24.76	-13.23	-30.06	-27.74	-13.46	-26.67	-27.46
2901-2912	7.98	-16.78	-5.25	$\boxed{-22.07}$	-19.76	$\boxed{-5.48}$	-18.69	-19.48
2901-3001	-20.50	-45.25	-33.73	-50.55	-48.24	-33.96	-47.17	-47.96
2902-3001	5.16	-19.59	-8.07	-24.89	-22.58	-8.30	-21.51	-22.30
2910-3009	23.53	-1.22	$\boxed{10.30}$	-6.52	-4.21	10.07	-3.14	-3.93
2910-3010	10.00	-14.76	-3.23	-20.06	-17.74	-3.46	-16.68	-17.46
2911-3010	6.88	-17.87	-6.35	-23.17	-20.86	-6.58	-19.79	-20.58
2912-3012	20.80	-3.96	7.57	-9.26	-6.94	7.34	-5.88	-6.66
3001-3012	13.49	-11.27	0.26	$\boxed{-16.57}$	$\boxed{-14.25}$	0.03	-13.18	$\boxed{-13.97}$
3001-3102	15.12	-9.64	1.89	-14.94	-12.63	1.66	-11.56	-12.34
3002-3101	12.77	-11.99	-0.47	-17.29	$\boxed{-14.98}$	-0.70	-13.91	-14.69
3002-3102	21.57	-3.19	8.34	-8.49	-6.17	8.11	-5.10	-5.89
3010-3109	34.39	9.63	21.16	4.33	$\boxed{6.65}$	20.93	7.71	6.93
3010-3110	-15.77	-40.52	-29.00	-45.82	-43.51	-29.23	-42.44	-43.23
3010-3111	10.37	-14.39	-2.86	$\boxed{-19.68}$	$\boxed{-17.37}$	-3.09	-16.30	-17.09
3011-3110	17.47	-7.29	4.24	-12.59	$\boxed{-10.27}$	4.01	-9.20	-9.99
3101-3112	19.95	$\boxed{-4.81}$	6.71	$\boxed{-10.11}$	$\boxed{-7.80}$	6.49	$\boxed{-6.73}$	$\boxed{-7.51}$
3101-3201	4.01	$\boxed{-20.75}$	-9.23	-26.05	-23.74	-9.45	-22.67	-23.45
3102-3202	5.97	-18.79	-7.27	-24.09	-21.78	-7.49	-20.71	$\boxed{-21.49}$
3106-3205	0.80	-23.96	-12.43	-29.26	-26.94	-12.66	-25.88	-26.66
3107-3206	27.87	3.11	14.64	-2.19	$\boxed{0.13}$	14.41	1.20	0.41
3107-3207	13.92	-10.83	0.69	-16.13	-13.82	0.46	-12.75	-13.53
3108-3208	19.53	-5.23	6.30	-10.53	-8.21	6.07	-7.14	$\boxed{-7.93}$
3109-3209	18.73	-6.02	5.50	-11.32	-9.01	5.27	-7.94	-8.73
3110-3209	-12.01	-36.76	-25.24	-42.06	-39.75	-25.47	-38.68	-39.46
3111-3210	-8.41	-33.16	-21.64	-38.46	-36.15	-21.87	-35.08	-35.86
3111-3211	5.03	-19.72	-8.20	-25.02	-22.71	-8.43	-21.64	-22.43
3112-3212	14.23	-10.52	1.00	-15.82	-13.51	0.77	-12.44	-13.23
3201-3212	15.55	$\boxed{-9.20}$	$\boxed{2.32}$	$\boxed{-14.50}$	-12.19	2.09	-11.12	$\boxed{-11.91}$
3201-3301	21.81	-2.95	8.58	-8.25	-5.93	8.35	-4.87	-5.65
3202-3301	10.42	-14.34	-2.81	-19.64	-17.32	-3.04	-16.25	-17.04

Year, Month \ Province	Coefficient	Kansu sw wwm	Ningsia sw	Shansi sw wwm	Shensi sw wwm sr	Suiyuan sw	Tsinghai sw	Honan wwm wwg yrw
Coefficient		-24.76	-13.23	-30.06	-27.74	-13.46	-26.67	-27.46
3202-3302	9.18	-15.57	-4.05	-20.87	-18.56	-4.28	-17.49	-18.28
3203-3302	2.95	-21.81	-10.28	-27.11	-24.79	-10.51	-23.73	-24.51
3205-3305	39.08	14.32	25.85	9.02	11.33	25.62	12.40	11.62
3206-3305	1.57	-23.19	-11.66	-28.49	-26.17	-11.89	-25.10	-25.89
3210-3309	0.51	-24.25	-12.73	-29.55	-27.24	-12.95	-26.17	-26.95

Table A-9 Coefficient and Covariance of Time Span and Provinces for the Ratio of Average to Best (2)

Year, Month \ Province	Coefficient	Hopeh wwm wwg	Anhwei wwg yrw rt	Kiangsu wwg yrw	Liaoning sw wwg	Shantung wwg	Chekiang yrw rt	Hupeh yrw
Coefficient		-14.68	-23.26	-21.28	-18.17	-26.56	-15.61	-7.17
2901-2912	7.98	$\boxed{-6.70}$	$\boxed{-15.27}$	$\boxed{-13.29}$	-10.19	$\boxed{-18.58}$	$\boxed{-7.63}$	$\boxed{0.81}$
2901-3001	-20.50	$\boxed{-35.18}$	-43.75	-41.77	-38.67	-47.06	-36.11	-27.67
2902-3001	5.16	-9.52	-18.09	-16.11	-13.01	-21.40	$\boxed{-10.45}$	-2.01
2910-3009	23.53	8.85	0.28	2.26	5.36	-3.03	$\boxed{7.92}$	16.36
2910-3010	10.00	-4.68	-13.26	$\boxed{-11.28}$	-8.17	-16.56	-5.61	2.83
2911-3010	6.88	-7.80	-16.37	-14.39	-11.29	$\boxed{-19.68}$	-8.73	-0.29
2912-3012	20.80	6.12	-2.46	$\boxed{-0.48}$	2.63	-5.76	5.19	13.63
3001-3012	13.49	$\boxed{-1.19}$	$\boxed{-9.76}$	$\boxed{-7.79}$	$\boxed{-4.68}$	$\boxed{-13.07}$	-2.12	$\boxed{6.32}$
3001-3102	15.12	0.44	-8.14	-6.16	-3.05	$\boxed{-11.44}$	-0.49	7.94
3002-3101	12.77	-1.92	-10.49	-8.51	-5.40	-13.80	-2.85	5.59
3002-3102	21.57	6.89	-1.68	0.30	3.40	-4.99	5.96	14.40
3010-3109	34.39	19.71	11.13	13.11	16.22	$\boxed{7.83}$	18.78	27.22
3010-3110	-15.77	-30.45	-39.02	-37.04	-33.94	-42.33	$\boxed{-31.38}$	-22.94
3010-3111	10.37	-4.31	-12.88	-10.90	-7.80	-16.19	-5.24	3.20
3011-3110	17.47	2.79	-5.79	-3.81	-0.70	$\boxed{-9.09}$	$\boxed{1.86}$	10.30
3101-3112	19.95	$\boxed{5.26}$	$\boxed{-3.31}$	-1.33	1.78	$\boxed{-6.62}$	$\boxed{4.34}$	12.77
3101-3201	4.01	-10.68	-19.25	-17.27	-14.16	-22.56	$\boxed{-11.60}$	-3.17
3102-3202	5.97	-8.72	-17.29	-15.31	-12.20	-20.60	-9.64	$\boxed{-1.21}$
3106-3205	0.80	-13.88	-22.46	$\boxed{-20.48}$	-17.37	-25.76	-14.81	-6.37
3107-3206	27.87	13.19	4.61	6.59	9.70	1.31	12.26	20.70

Province / Coefficient / Year, Month		Hopeh wwm wwg	Anhwei wwg yrw rt	Kiangsu wwg yrw	Liaoning sw wwg	Shantung wwg	Chekiang yrw rt	Hupeh yrw
Coefficient		-14.68	-23.26	-21.28	-18.17	-26.56	-15.61	-7.17
3107-3207	13.92	-0.76	-9.33	-7.35	-4.24	-12.64	-1.69	6.75
3108-3208	19.53	4.85	-3.72	-1.75	1.36	-7.03	3.92	12.36
3109-3209	18.73	4.05	-4.52	-2.54	0.56	-7.83	3.12	11.56
3110-3209	-12.01	-26.69	-35.26	-33.28	-30.17	-38.57	-27.62	-19.18
3111-3210	-8.41	-23.09	-31.66	-29.68	-26.57	-34.97	-24.02	-15.58
3111-3211	5.03	-9.65	-18.22	-16.24	-13.14	-21.53	-10.58	-2.14
3112-3212	14.23	-0.45	-9.02	-7.04	-3.94	-12.33	-1.38	7.06
3201-3212	15.55	0.87	-7.70	-5.72	-2.62	-11.01	-0.06	8.38
3201-3301	21.81	7.13	-1.45	0.53	3.64	-4.75	6.20	14.64
3202-3301	10.42	-4.26	-12.83	-10.85	-7.75	-16.14	-5.19	3.25
3202-3302	9.18	-5.50	-14.07	-12.09	-8.99	-17.38	-6.43	2.01
3203-3302	2.95	-11.73	-20.31	-18.33	-15.22	-23.61	-12.66	-4.22
3205-3305	39.08	24.40	15.82	17.80	20.91	12.52	23.47	31.91
3206-3305	1.57	-13.11	-21.68	-19.71	-16.60	-24.99	-14.04	-5.60
3210-3309	0.51	-14.18	-22.75	-20.77	-17.66	-26.06	-15.10	-6.67

Table A-9 Coefficient and Covariance of Time Span and Provinces for the Ratio of Average to Best (3)

Province / Coefficient / Year,Month		Kiangsi yrw rt dcr	Fukien rt dcr	Szechwan szr	Kwangsi rt dcr	Kwang -tung dcr	Kwei -chow swr	Yunnan swr
Coefficient		-12.74	-9.87	-5.90	-15.54	-18.58	-15.99	-17.38
2901-2912	7.98	-4.76	-1.89	2.08	-7.56	-10.59	-8.01	-9.40
2901-3001	-20.50	-33.24	-30.37	-26.40	-36.04	-39.07	-36.49	-37.88
2902-3001	5.16	-7.58	-4.71	-0.74	-10.38	-13.41	-10.83	-12.22
2910-3009	23.53	10.79	13.66	17.63	7.99	4.96	7.54	6.15
2910-3010	10.00	-2.74	0.13	4.10	-5.54	-8.58	-6.00	-7.38
2911-3010	6.88	-5.86	-2.99	0.98	-8.65	-11.69	-9.11	-10.50
2912-3012	20.80	8.06	10.93	14.90	5.26	2.22	4.80	3.42
3001-3012	13.49	0.75	3.62	7.59	-2.05	-5.09	-2.50	-3.89
3001-3102	15.12	2.38	5.25	9.22	-0.42	-3.46	-0.88	-2.26
3002-3101	12.77	0.02	2.89	6.87	-2.77	-5.81	-3.23	-4.61
3002-3102	21.57	8.83	11.70	15.67	6.03	2.99	5.58	4.19

Province / Year,Month	Coefficient	Kiangsi yrw rt dcr	Fukien rt dcr	Szechwan szr	Kwangsi rt dcr	Kwang -tung dcr	Kwei -chow swr	Yunnan swr
Coefficient		-12.74	-9.87	-5.90	-15.54	-18.58	-15.99	-17.38
3010-3109	34.39	21.65	24.52	28.49	18.85	15.81	18.39	17.01
3010-3110	-15.77	-28.51	-25.64	-21.67	-31.31	-34.34	-31.76	-33.15
3010-3111	10.37	-2.37	0.50	4.47	-5.17	-8.21	-5.62	-7.01
3011-3110	17.47	4.73	7.60	11.57	1.93	-1.11	1.48	0.09
3101-3112	19.95	7.20	10.08	$\boxed{14.05}$	4.41	1.37	3.95	2.57
3101-3201	4.01	-8.74	-5.86	-1.89	-11.53	-14.57	-11.99	-13.37
3102-3202	5.97	-6.78	-3.91	0.07	-9.57	-12.61	-10.03	-11.41
3106-3205	0.80	-11.94	-9.07	-5.10	-14.74	-17.78	-15.20	-16.58
3107-3206	27.87	15.13	18.00	$\boxed{21.97}$	12.33	9.29	11.88	10.49
3107-3207	13.92	1.18	$\boxed{4.05}$	8.03	-1.61	-4.65	-2.07	-3.45
3108-3208	19.53	6.79	$\boxed{9.66}$	13.63	3.99	0.95	3.54	2.15
3109-3209	18.73	5.99	8.86	12.83	3.19	0.16	2.74	1.35
3110-3209	-12.01	-24.75	-21.88	-17.90	-27.54	-30.58	-28.00	-29.38
3111-3210	-8.41	-21.15	-18.28	-14.30	-23.94	-26.98	-24.40	-25.78
3111-3211	5.03	-7.71	-4.84	-0.87	-10.51	-13.54	-10.96	-12.35
3112-3212	14.23	1.49	4.36	8.33	-1.31	-4.34	-1.76	-3.15
3201-3212	15.55	$\boxed{2.81}$	5.68	9.65	$\boxed{0.02}$	$\boxed{-3.02}$	$\boxed{-0.44}$	$\boxed{-1.83}$
3201-3301	21.81	9.07	11.94	15.91	6.27	$\boxed{3.23}$	5.81	4.43
3202-3301	10.42	-2.32	0.55	4.52	-5.12	-8.16	-5.57	-6.96
3202-3302	9.18	-3.56	-0.69	3.28	-6.35	-9.39	-6.81	-8.20
3203-3302	2.95	-9.79	-6.92	-2.95	-12.59	-15.63	-13.05	-14.43
3205-3305	39.08	26.34	29.21	33.18	23.54	20.50	23.08	21.70
3206-3305	1.57	$\boxed{-11.17}$	-8.30	-4.33	-13.97	-17.01	-14.42	-15.81
3210-3309	0.51	-12.24	-9.36	-5.39	-15.03	-18.07	-15.49	-16.87

2) Restricted Regression with Agricultural Areas and Time Span

regress ratio_avg_to_best spring_wheat winter_wheat_millet winter_wheat_gaoliang yangtze_rice_wheat szechwan_rice double_cropping_rice southwestern_rice yr1929_01_12 yr1929_01_1930_01 yr1929_02_1930_01 yr1929_10_1930_09 yr1929_10_1930_10 yr1929_11_1930_10 yr1929_12_1930_12 yr1930_01_12 yr1930_01_1931_02 yr1930_02_1931_01 yr1930_02_1931_02 yr1930_10_1931_09 yr1930_10_1931_10 yr1930_10_1931_11 yr1930_11_1931_10 yr1931_01_12 yr1931_01_1932_01 yr1931_02_1932_02 yr1931_06_1932_05 yr1931_07_1932_06 yr1931_07_1932_07 yr1931_08_1932_08 yr1931_09_1932_09 yr1931_10_1932_09 yr1931_11_1932_10 yr1931_11_1932_11 yr1931_12_1932_12 yr1932_01_12 yr1932_01_1933_01 yr1932_02_1933_01 yr1932_02_1933_02 yr1932_03_1933_02 yr1932_05_1933_05 yr1932_06_1933_05 yr1932_10_1933_09, r

Test for heteroskedasticity:

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_best

         chi2(1)      =     1.13
         Prob > chi2  =   0.2880
```

Table A-10 Coefficient and Covariance of Time Span and Agricultural Areas for the Ratio of Average to Best

Agricultural Area / Coefficient / Year,Month		Spring wheat	Winter Wheat millet	Winter Wheat gaoliang	Yangtze Rice wheat	Szechwan rice	Double Cropping rice	South-western rice
Coefficient		-15.65	-19.15	-12.62	-11.24	2.17	-6.16	-4.47
2901-2912	3.10	-12.55	-16.05	-9.51	-8.14	5.27	-3.06	-1.36
2901-3001	-19.96	-35.61	-39.11	-32.57	-31.20	-17.79	-26.12	-24.43
2902-3001	0.65	-15.01	-18.51	-11.97	-10.59	2.81	-5.52	-3.82
2910-3009	10.53	-5.13	-8.63	-2.09	-0.71	12.69	4.36	6.06
2910-3010	2.56	-13.09	-16.59	-10.05	-8.67	4.73	-3.60	-1.90
2911-3010	-4.46	-20.11	-23.61	-17.07	-15.70	-2.29	-10.62	-8.93
2912-3012	13.36	-2.29	-5.79	0.75	2.13	15.53	7.20	8.90
3001-3012	7.81	-7.85	-11.35	-4.81	-3.43	9.97	1.64	3.34
3001-3102	3.77	-11.88	-15.38	-8.84	-7.46	5.94	-2.39	-0.69
3002-3101	3.28	-12.37	-15.87	-9.34	-7.96	5.45	-2.88	-1.19
3002-3102	14.66	-0.99	-4.49	2.04	3.42	16.83	8.50	10.19
3010-3109	15.06	-0.59	-4.09	2.45	3.82	17.23	8.90	10.59
3010-3110	-17.54	-33.19	-36.69	-30.15	-28.77	-15.37	-23.70	-22.00
3010-3111	3.23	-12.43	-15.92	-9.39	-8.01	5.40	-2.93	-1.24
3011-3110	6.87	-8.79	-12.29	-5.75	-4.37	9.03	0.71	2.40
3101-3112	13.63	-2.02	-5.52	1.02	2.39	15.80	7.47	9.16
3101-3201	-5.75	-21.40	-24.90	-18.36	-16.99	-3.58	-11.91	-10.22
3102-3202	7.91	-7.75	-11.25	-4.71	-3.33	10.08	1.75	3.44
3106-3205	-6.64	-22.29	-25.79	-19.25	-17.87	-4.47	-12.80	-11.10
3107-3206	22.14	6.49	2.99	9.53	10.91	24.31	15.98	17.68
3107-3207	12.82	-2.84	-6.34	0.20	1.58	14.99	6.66	8.35
3108-3208	9.17	-6.49	-9.99	-3.45	-2.07	11.33	3.01	4.70
3109-3209	5.73	-9.93	-13.43	-6.89	-5.51	7.89	-0.44	1.26
3110-3209	-5.34	-20.99	-24.49	-17.95	-16.57	-3.17	-11.50	-9.80
3111-3210	-1.74	-17.39	-20.89	-14.35	-12.97	0.43	-7.90	-6.20
3111-3211	-7.97	-23.63	-27.13	-20.59	-19.21	-5.81	-14.14	-12.44
3112-3212	1.23	-14.43	-17.93	-11.39	-10.01	3.39	-4.94	-3.24
3201-3212	5.81	-9.84	-13.34	-6.80	-5.43	7.98	-0.35	1.34
3201-3301	12.00	-3.66	-7.16	-0.62	0.76	14.16	5.84	7.53
3202-3301	13.03	-2.63	-6.13	0.41	1.79	15.19	6.86	8.56
3202-3302	-2.16	-17.81	-21.31	-14.77	-13.40	0.01	-8.32	-6.63

Agricultural Area / Coefficient / Year,Month		Spring wheat	Winter Wheat millet	Winter Wheat gaoliang	Yangtze Rice wheat	Szechwan rice	Double Cropping rice	South-western rice
Coefficient		-15.65	-19.15	-12.62	-11.24	2.17	-6.16	-4.47
3203-3302	5.55	-10.10	-13.60	-7.06	-5.69	7.72	-0.61	1.08
3205-3305	29.66	14.01	10.51	17.05	18.43	31.83	23.50	25.20
3206-3305	-2.59	-18.24	-21.74	-15.20	-13.82	-0.42	-8.75	-7.05
3210-3309	-3.12	-18.78	-22.28	-15.74	-14.36	-0.95	-9.28	-7.59

Further Regressions about Calamities and Conflicts

For Ratio of Average to Normal:
Restricted Regression with Provinces, Calamities and Conflicts

regress ratio_avg_to_normal kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr major_drought major_drought_plus_1 major_flood major_flood_plus_1 communism communist_suppression civil_war northern_war, r

```
Linear regression                                      Number of obs =     201
                                                       F( 27,   171) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.2358
                                                       Root MSE      =  12.991
```

ratio_avg_to_normal	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
kansu_sw_wwm	-9.44042	10.48876	-0.90	0.369	-30.14455	11.26371
ningsia_sw	.6995792	3.362568	0.21	0.835	-5.937907	7.337066
shansi_sw_wwm	-19.66877	3.874536	-5.08	0.000	-27.31685	-12.02069
shensi_sw_wwm_sr	-10.6725	6.174454	-1.73	0.086	-22.86047	1.515461
suiyuan_sw	9.497109	3.348917	2.84	0.005	2.886568	16.10765
tsinghai_sw	-10.75042	3.744809	-2.87	0.005	-18.14242	-3.358411
honan_wwm_wwg_yrw	-10.11365	4.616812	-2.19	0.030	-19.22693	-1.000367
hopeh_wwm_wwg	-4.792725	7.921435	-0.61	0.546	-20.42911	10.84366
anhwei_wwg_yrw_rt	-14.56927	5.635316	-2.59	0.011	-25.69301	-3.445527
kiangsu_wwg_yrw	-18.39632	5.487202	-3.35	0.001	-29.22769	-7.564944
liaoning_sw_wwg	-28.60042	3.362568	-8.51	0.000	-35.23791	-21.96293
shantung_wwg	-17.48887	5.591886	-3.13	0.002	-28.52689	-6.450859
chekiang_yrw_rt	-13.35557	5.374547	-2.48	0.014	-23.96457	-2.74657
hupeh_yrw	-17.27467	3.386811	-5.10	0.000	-23.96001	-10.58933
kiangsi_yrw_rt_dcr	-.2587862	6.27928	-0.04	0.967	-12.65367	12.1361
fukien_rt_dcr	-4.695083	3.903147	-1.20	0.231	-12.39964	3.009471
szechwan_szr	-1.088833	4.150524	-0.26	0.793	-9.281693	7.104026
kwangsi_rt_dcr	-13.96145	4.234558	-3.30	0.001	-22.32019	-5.602716
kwangtung_dcr	-10.33337	4.718847	-2.19	0.030	-19.64806	-1.018677
kweichow_swr	-7.630079	4.558472	-1.67	0.096	-16.6282	1.368044
yunnan_swr	-11.09929	3.502981	-3.17	0.002	-18.01394	-4.184634
major_drought	-7.19614	3.881172	-1.85	0.065	-14.85732	.4650366
major_drought_plus_1	-15.75366	9.181148	-1.72	0.088	-33.87664	2.369324
major_flood	-9.751392	3.458128	-2.82	0.005	-16.57751	-2.925275
major_flood_plus_1	-1.717911	4.49593	-0.38	0.703	-10.59258	7.156757
communism	3.334564	2.974853	1.12	0.264	-2.537599	9.206726
communist_suppression	1.990568	3.913976	0.51	0.612	-5.735362	9.716498
civil_war	-.3216592	5.389147	-0.06	0.952	-10.95948	10.31616
northern_war	4.839897	5.224915	0.93	0.356	-5.473741	15.15353
_cons	91.90042	3.362568	27.33	0.000	85.26293	98.53791

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_normal

         chi2(1)      =     0.15
         Prob > chi2  =   0.6983
```

Table A-11 Coefficient of Provinces, Calamities and Conflicts for the Ratio of Average to Normal (1)

Calamity / Conflict \ Province		Kansu sw wwm	Ningsia sw	Shansi sw wwm	Shensi sw wwm sr	Suiyuan sw	Tsinghai sw	Honan wwm wwg yrw
Coefficient	Coefficient	-9.44	0.70	-19.67	-10.67	9.50	-10.75	-10.11
Major drought	-7.20	-16.64	-6.50	$\boxed{-26.86}$	-17.87	$\boxed{2.30}$	-17.95	-17.31
Major drought +1	-15.75	-25.19	-15.05	-35.42	$\boxed{-26.43}$	-6.26	-26.50	$\boxed{-25.87}$
Major flood	-9.75	-19.19	-9.05	-29.42	$\boxed{-20.42}$	$\boxed{-0.25}$	-20.50	$\boxed{-19.87}$
Major flood +1	-1.72	-11.16	-1.02	-21.39	-12.39	7.78	-12.47	$\boxed{-11.83}$
Communism	3.33	-6.11	4.03	$\boxed{-16.33}$	-7.34	12.83	-7.42	$\boxed{-6.78}$
Communist suppression	1.99	-7.45	2.69	-17.68	-8.68	11.49	-8.76	$\boxed{-8.12}$
Civil war	-0.32	-9.76	0.38	-19.99	$\boxed{-10.99}$	9.18	-11.07	-10.44
Northern war	4.84	-4.60	5.54	-14.83	-5.83	14.34	-5.91	$\boxed{-5.27}$

Table A-11 Coefficient of Provinces, Calamities and Conflicts for the Ratio of Average to Normal (2)

Calamity / Conflict \ Province		Hopeh wwm wwg	Anhwei wwg yrw rt	Kiangsu wwg yrw	Liaoning sw wwg	Shan -tung wwg	Che -kiang yrw rt	Hupeh yrw
Coefficient	Coefficient	-4.79	-14.57	-18.40	-28.60	-17.49	-13.36	-17.27
Major drought	-7.20	-11.99	$\boxed{-21.77}$	-25.59	-35.80	-24.69	-20.55	-24.47
Major drought +1	-15.75	-20.55	-30.32	-34.15	-44.35	-33.24	$\boxed{-29.11}$	-33.03
Major flood	-9.75	-14.54	-24.32	$\boxed{-28.15}$	-38.35	$\boxed{-27.24}$	-23.11	$\boxed{-27.03}$
Major flood +1	-1.72	-6.51	$\boxed{-16.29}$	$\boxed{-20.11}$	-30.32	-19.21	-15.07	-18.99
Communism	3.33	-1.46	$\boxed{-11.23}$	$\boxed{-15.06}$	-25.27	$\boxed{-14.15}$	$\boxed{-10.02}$	$\boxed{-13.94}$
Communist suppression	1.99	-2.80	$\boxed{-12.58}$	-16.41	-26.61	-15.50	-11.37	$\boxed{-15.28}$
Civil war	-0.32	-5.11	-14.89	-18.72	-28.92	$\boxed{-17.81}$	-13.68	-17.60
Northern war	4.84	0.05	-9.73	$\boxed{-13.56}$	-23.76	$\boxed{-12.65}$	-8.52	-12.43

Table A-11 Coefficient of Provinces, Calamities and Conflicts for the Ratio of Average to Normal (3)

Province Coefficient / Calamity Conflict Coefficient		Kiangsi yrw rt dcr	Fukien rt dcr	Szech -wan szr	Kwangsi rt dcr	Kwang -tung dcr	Kwei -chow swr	Yunnan swr
		-0.26	-4.70	-1.09	-13.96	-10.33	-7.63	-11.10
Major drought	-7.20	-7.45	-11.89	-8.28	-21.16	-17.53	-14.83	-18.30
Major drought +1	-15.75	-16.01	-20.45	-16.84	-29.72	-26.09	-23.38	-26.85
Major flood	-9.75	-10.01	-14.45	-10.84	-23.71	-20.08	-17.38	-20.85
Major flood +1	-1.72	-1.98	-6.41	-2.81	-15.68	-12.05	-9.35	-12.82
Communism	3.33	3.08	-1.36	2.25	-10.63	-7.00	-4.30	-7.76
Communist suppression	1.99	1.73	-2.70	0.90	-11.97	-8.34	-5.64	-9.11
Civil war	-0.32	-0.58	-5.02	-1.41	-14.28	-10.66	-7.95	-11.42
Northern war	4.84	4.58	0.14	3.75	-9.12	-5.49	-2.79	-6.26

For Ratio of Average to Best

Restricted Regression with Provinces, Calamities and Conflicts

regress ratio_avg_to_best kansu_sw_wwm ningsia_sw shansi_sw_wwm shensi_sw_wwm_sr suiyuan_sw tsinghai_sw honan_wwm_wwg_yrw hopeh_wwm_wwg anhwei_wwg_yrw_rt kiangsu_wwg_yrw liaoning_sw_wwg shantung_wwg chekiang_yrw_rt hupeh_yrw kiangsi_yrw_rt_dcr fukien_rt_dcr szechwan_szr kwangsi_rt_dcr kwangtung_dcr kweichow_swr yunnan_swr major_drought major_drought_plus_1 major_flood major_flood_plus_1 communism communist_suppression civil_war northern_war, r

```
Linear regression                                      Number of obs =     201
                                                       F( 27,   171) =       .
                                                       Prob > F      =       .
                                                       R-squared     =  0.2660
                                                       Root MSE      =  12.046
```

ratio_avg_to_best	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
kansu_sw_wwm	-21.99107	8.061877	-2.73	0.007	-37.90468	-6.077452
ningsia_sw	-10.79107	3.634124	-2.97	0.003	-17.96459	-3.617547
shansi_sw_wwm	-27.88907	3.951545	-7.06	0.000	-35.68916	-20.08899
shensi_sw_wwm_sr	-13.47017	7.148765	-1.88	0.061	-27.58136	.6410236
suiyuan_sw	-3.771569	6.705773	-0.56	0.575	-17.00832	9.465185
tsinghai_sw	-19.84107	3.739534	-5.31	0.000	-27.22266	-12.45947
honan_wwm_wwg_yrw	-20.42755	4.341078	-4.71	0.000	-28.99655	-11.85855
hopeh_wwm_wwg	-15.70645	7.121945	-2.21	0.029	-29.7647	-1.648202
anhwei_wwg_yrw_rt	-21.19403	5.942727	-3.57	0.000	-32.92458	-9.46348
kiangsu_wwg_yrw	-25.04141	5.795039	-4.32	0.000	-36.48044	-13.60239
liaoning_sw_wwg	-17.79107	3.634124	-4.90	0.000	-24.96459	-10.61755
shantung_wwg	-27.61012	5.450457	-5.07	0.000	-38.36897	-16.85128
chekiang_yrw_rt	-15.01745	5.414923	-2.77	0.006	-25.70615	-4.328748
hupeh_yrw	-18.61502	3.557987	-5.23	0.000	-25.63825	-11.59179
kiangsi_yrw_rt_dcr	-6.396688	5.348584	-1.20	0.233	-16.95444	4.161064
fukien_rt_dcr	-9.679237	3.941321	-2.46	0.015	-17.45914	-1.899329
szechwan_szr	-4.803345	4.781144	-1.00	0.316	-14.24101	4.634317
kwangsi_rt_dcr	-15.4835	6.485142	-2.39	0.018	-28.28474	-2.682257
kwangtung_dcr	-16.41094	4.306096	-3.81	0.000	-24.91089	-7.910988
kweichow_swr	-14.36333	5.241728	-2.74	0.007	-24.71015	-4.016501
yunnan_swr	-15.12378	3.804342	-3.98	0.000	-22.6333	-7.614265
major_drought	-6.97616	4.807612	-1.45	0.149	-16.46607	2.513748
major_drought_plus_1	-14.92711	8.774892	-1.70	0.091	-32.24816	2.39395
major_flood	-7.843338	3.464835	-2.26	0.025	-14.68269	-1.003982
major_flood_plus_1	.6463284	3.990509	0.16	0.872	-7.230673	8.52333
communism	2.385397	2.529353	0.94	0.347	-2.607378	7.378173
communist_suppression	.838061	3.380139	0.25	0.804	-5.834111	7.510233
civil_war	3.737161	6.611331	0.57	0.573	-9.313169	16.78749
northern_war	6.272253	4.792236	1.31	0.192	-3.187305	15.73181
_cons	88.39107	3.634124	24.32	0.000	81.21755	95.56459

hettest

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ratio_avg_to_best

         chi2(1)      =     7.20
         Prob > chi2  =   0.0073
```

Table A-12 Coefficient of Provinces, Calamities and Conflicts for the Ratio of Average to Best (1)

Calamity / Conflict (Coefficient) \ Province (Coefficient)		Kansu sw wwm	Ningsia sw	Shansi sw wwm	Shensi sw wwm sr	Suiyuan sw	Tsinghai sw	Honan wwm wwg yrw
Coefficient		-21.99	-10.79	-27.89	-13.47	-3.77	-19.84	-20.43
Major drought	-6.98	-28.97	-17.77	$\boxed{-34.87}$	-20.45	$\boxed{-10.75}$	-26.82	-27.40
Major drought +1	-14.93	-36.92	-25.72	-42.82	$\boxed{-28.40}$	-18.70	-34.77	$\boxed{-35.35}$
Major flood	-7.84	-29.83	-18.63	-35.73	$\boxed{-21.31}$	$\boxed{-11.61}$	-27.68	$\boxed{-28.27}$
Major flood +1	0.65	-21.34	-10.14	-27.24	-12.82	-3.13	-19.19	$\boxed{-19.78}$
Communism	2.39	-19.61	-8.41	$\boxed{-25.50}$	-11.08	-1.39	-17.46	$\boxed{-18.04}$
Communist suppression	0.84	-21.15	-9.95	-27.05	-12.63	-2.93	-19.00	$\boxed{-19.59}$
Civil war	3.74	-18.25	-7.05	-24.15	$\boxed{-9.73}$	-0.03	-16.10	-16.69
Northern war	6.27	-15.72	-4.52	-21.62	-7.20	2.50	-13.57	$\boxed{-14.16}$

Table A-12 Coefficient of Provinces, Calamities and Conflicts for the Ratio of Average to Best (2)

Calamity / Conflict (Coefficient) \ Province (Coefficient)		Hopeh wwm wwg	Anhwei wwg yrw rt	Kiangsu wwg yrw	Liaoning sw wwg	Shantung wwg	Che -kiang yrw rt	Hupeh yrw
Coefficient		-15.71	-21.19	-25.04	-17.79	-27.61	-15.02	-18.62
Major drought	-6.98	-22.68	$\boxed{-28.17}$	-32.02	-24.77	-34.59	-21.99	-25.59
Major drought +1	-14.93	-30.63	-36.12	-39.97	-32.72	-42.54	$\boxed{-29.94}$	-33.54
Major flood	-7.84	-23.55	-29.04	$\boxed{-32.88}$	-25.63	$\boxed{-35.45}$	-22.86	$\boxed{-26.46}$
Major flood +1	0.65	-15.06	$\boxed{-20.55}$	$\boxed{-24.40}$	-17.14	-26.96	-14.37	-17.97
Communism	2.39	-13.32	$\boxed{-18.81}$	$\boxed{-22.66}$	-15.41	$\boxed{-25.22}$	$\boxed{-12.63}$	$\boxed{-16.23}$
Communist suppression	0.84	-14.87	$\boxed{-20.36}$	-24.20	-16.95	-26.77	-14.18	$\boxed{-17.78}$
Civil war	3.74	-11.97	-17.46	-21.30	-14.05	$\boxed{-23.87}$	-11.28	-14.88
Northern war	6.27	-9.43	-14.92	$\boxed{-18.77}$	-11.52	$\boxed{-21.34}$	-8.75	-12.34

Table A-12 Coefficient of Provinces, Calamities and Conflicts for the Ratio of Average to Best (3)

Calamity / Conflict (Province →)	Coefficient	Kiangsi yrw rt dcr	Fukien rt dcr	Szech-wan szr	Kwangsi rt dcr	Kwang-tung dcr	Kwei-chow swr	Yunnan swr
Coefficient		-6.40	-9.68	-4.80	-15.48	-16.41	-14.36	-15.12
Major drought	-6.98	-13.37	-16.66	-11.78	-22.46	-23.39	-21.34	-22.10
Major drought +1	-14.93	-21.32	-24.61	-19.73	-30.41	-31.34	-29.29	-30.05
Major flood	-7.84	$\boxed{-14.24}$	-17.52	-12.65	-23.33	-24.25	-22.21	-22.97
Major flood +1	0.65	$\boxed{-5.75}$	-9.03	-4.16	-14.84	-15.76	$\boxed{-13.72}$	$\boxed{-14.48}$
Communism	2.39	$\boxed{-4.01}$	$\boxed{-7.29}$	-2.42	$\boxed{-13.10}$	$\boxed{-14.03}$	-11.98	-12.74
Communist suppression	0.84	$\boxed{-5.56}$	-8.84	-3.97	-14.65	$\boxed{-15.57}$	$\boxed{-13.53}$	$\boxed{-14.29}$
Civil war	3.74	-2.66	-5.94	-1.07	-11.75	-12.67	-10.63	-11.39
Northern war	6.27	-0.12	-3.41	1.47	-9.21	-10.14	-8.09	-8.85

Description of Locality Surveyed

Table A-13 Time Span, Agricultural Area, and Province for Each Locality

Locality	Time Span	Agr. Area	Province	Locality	Time Span	Agr. Area	Province
Chenfan		SW	Kansu	Wutsin(2)	2901-2912	YRW	Kiangsu
Kaolan (1)	3101-3112	SW	Kansu	Wutsin(3)	3201-3212	YRW	Kiangsu
Kaolan (2)	3101-3201	SW	Kansu	Yencheng(1)	2901-2912	YRW	Kiangsu
Linsia		SW	Kansu	Yencheng(2)	2910-3010	YRW	Kiangsu
Wuwei	3201-3212	SW	Kansu	Yencheng(3)	3001-3012	YRW	Kiangsu
Yungteng		SW	Kansu	Yencheng(4)	3001-3012	YRW	Kiangsu
Tuchuan		SW	Liaoning	Shih		RT	Anhwei
Ningsia	3201-3212	SW	Ningsia	Shihtai		RT	Anhwei
Ningwu(1)	3201-3212	SW	Shansi	Siuning	3201-3212	RT	Anhwei
Ningwu(2)	3201-3212	SW	Shansi	Suancheng		RT	Anhwei
Ningwu(3)	3201-3212	SW	Shansi	Taiping		RT	Anhwei
Tatung	2901-2912	SW	Shansi	Tsingyang		RT	Anhwei
Tsinglo	2901-2912	SW	Shansi	Wuyuan		RT	Anhwei
Hwangyuan	3101-3112	SW	Tsinghai	Chuki		RT	Chekiang
Kweiteh(1)		SW	Tsinghai	Fenghwa	3101-3112	RT	Chekiang
Kweiteh(2)		SW	Tsinghai	Fuyang		RT	Chekiang
Sining	3101-3112	SW	Tsinghai	Hwangyen		RT	Chekiang
Weiyuan		SW	Tsinghai	Kinhwa		RT	Chekiang
Yushu		SW	Tsinghai	Lanki		RT	Chekiang
Tingpien	3001-3012	SW	Shensi	Linan		RT	Chekiang
Yulin	3002-3101	SW	Shensi	Linhai	3111-3211	RT	Chekiang
Kweisui	2901-2912	SW	Suiyuan	Lishui	3112-3212	RT	Chekiang
Paotow	2901-2912	SW	Suiyuan	Ning		RT	Chekiang
Lingpao	3101-3112	WWM	Honan	Shaohing		RT	Chekiang
Loyang(1)	3101-3112	WWM	Honan	Shunan(2)	2910-3009	RT	Chekiang
Loyang(2)	3101-3112	WWM	Honan	Sinteng		RT	Chekiang
Tsiyuan	3001-3012	WWM	Honan	Tangki	3101-3201	RT	Chekiang
Fowping(1)	3101-3112	WWM	Hopeh	Tunglu(1)	3108-3208	RT	Chekiang
Fowping(2)	3101-3112	WWM	Hopeh	Tunglu(2)	3108-3208	RT	Chekiang
Fowping(3)	3101-3112	WWM	Hopeh	Tungyang	3011-3110	RT	Chekiang
Pingliang	3101-3112	WWM	Kansu	Yungkia	3109-3209	RT	Chekiang

Locality	Time Span	Agr. Area	Province	Locality	Time Span	Agr. Area	Province
Tienshui	3101-3112	WWM	Kansu	Yuyao(2)		RT	Chekiang
Anyi	3010-3111	WWM	Shansi	Changting		RT	Fukien
Lin(1)	3101-3112	WWM	Shansi	Minhow	2902-3001	RT	Fukien
Lin(2)	3101-3112	WWM	Shansi	Nanping	3108-3208	RT	Fukien
Lin(3)	3101-3112	WWM	Shansi	Changsha		RT	Hunan
Lin(4)	3101-3112	WWM	Shansi	Changteh	3210-3309	RT	Hunan
Lin(5)	3101-3112	WWM	Shansi	Chen(2)	3202-3301	RT	Hunan
Pingting(1)	3101-3112	WWM	Shansi	Hengshan(1)		RT	Hunan
Pingting(2)	3101-3112	WWM	Shansi	Hengshan(2)		RT	Hunan
Pingting(3)	3101-3112	WWM	Shansi	Ichang(1)		RT	Hunan
Showyang(1)	3101-3112	WWM	Shansi	Ichang(2)		RT	Hunan
Showyang(2)	3101-3112	WWM	Shansi	Leiyang(1)		RT	Hunan
Showyang(3)	3101-3112	WWM	Shansi	Leiyang(2)		RT	Hunan
Sin	2901-2912	WWM	Shansi	Liling(1)		RT	Hunan
Taiku	2901-2912	WWM	Shansi	Liling(2)		RT	Hunan
Tsincheng	3001-3012	WWM	Shansi	Ningsiang(1)		RT	Hunan
Tsingyuan	3001-3012	WWM	Shansi	Ningsiang(2)		RT	Hunan
Wusiang	2901-2912	WWM	Shansi	Ningsiang(3)		RT	Hunan
Changan		WWM	Shensi	Shaoyang(1)		RT	Hunan
Chenan	3101-3112	WWM	Shensi	Shaoyang(2)		RT	Hunan
Chowchih	3011-3110	WWM	Shensi	Siangtan		RT	Hunan
Fengsiang		WWM	Shensi	Sinhwa	3203-3302	RT	Hunan
Fu		WWM	Shensi	Taoyuan(1)		RT	Hunan
Fufeng		WWM	Shensi	Taoyuan(2)		RT	Hunan
Fushih		WWM	Shensi	Wukang	3203-3302	RT	Hunan
Hancheng		WWM	Shensi	Yiyang(1)	3211-3310	RT	Hunan
Hingping(1)		WWM	Shensi	Yiyang(2)	3211-3310	RT	Hunan
Hingping(2)		WWM	Shensi	Yiyang(3)	3211-3310	RT	Hunan
Hingping(3)		WWM	Shensi	Yoyang		RT	Hunan
Hu		WWM	Shensi	Yu(1)		RT	Hunan
Hwa		WWM	Shensi	Yu(2)		RT	Hunan
Ichuin		WWM	Shensi	Fowliang	3201-3212	RT	Kiangsi
Lintung		WWM	Shensi	Hukow(1)		RT	Kiangsi
Shang	3107-3206	WWM	Shensi	Hukow(2)		RT	Kiangsi
Sienyang(1)		WWM	Shensi	Kaoan	3201-3212	RT	Kiangsi

Locality	Time Span	Agr. Area	Province	Locality	Time Span	Agr. Area	Province
Sienyang(2)		WWM	Shensi	Nanchang(1)	3201-3212	RT	Kiangsi
Sunyi	3101-3112	WWM	Shensi	Nanchang(2)	3201-3212	RT	Kiangsi
Tali		WWM	Shensi	Nanchang(3)	3201-3212	RT	Kiangsi
Weinan	3010-3111	WWM	Shensi	Nanchang(4)	3201-3212	RT	Kiangsi
Wukung(1)		WWM	Shensi	Nanchang(5)	3201-3212	RT	Kiangsi
Wukung(2)		WWM	Shensi	Pingsiang		RT	Kiangsi
Wukung(3)		WWM	Shensi	Poyang(1)		RT	Kiangsi
Fowyang	3201-3212	WWG	Anhwei	Poyang(2)		RT	Kiangsi
Su	3001-3012	WWG	Anhwei	Poyang(3)		RT	Kiangsi
Anyang		WWG	Honan	Poyang(4)		RT	Kiangsi
Chi	3001-3012	WWG	Honan	Teian(1)	3201-3212	RT	Kiangsi
Hiangcheng	3108-3208	WWG	Honan	Teian(2)	3201-3212	RT	Kiangsi
Kaifeng	3108-3208	WWG	Honan	Teian(3)	3201-3212	RT	Kiangsi
Linchang(1)	3101-3112	WWG	Honan	Tuchang(1)	3201-3212	RT	Kiangsi
Linchang(2)	3101-3112	WWG	Honan	Tuchang(2)	3201-3212	RT	Kiangsi
Linchang(3)	3101-3112	WWG	Honan	Mien	3010-3109	SZR	Shensi
Mengtsing		WWG	Honan	Nancheng(1)		SZR	Shensi
Nanyang	3108-3208	WWG	Honan	Nancheng(2)		SZR	Shensi
Shangkiu	3102-3202	WWG	Honan	Nancheng(3)		SZR	Shensi
Siuwu		WWG	Honan	Nancheng(4)		SZR	Shensi
Tsinyang	3001-3012	WWG	Honan	Nancheng(5)		SZR	Shensi
Yencheng	3201-3212	WWG	Honan	Chengtu		SZR	Szechwan
Changli(1)	2901-3001	WWG	Hopeh	Chung		SZR	Szechwan
Changli(2)	3001-3012	WWG	Hopeh	Chungking	2901-2912	SZR	Szechwan
Chengting(1)	3101-3112	WWG	Hopeh	Fengtu		SZR	Szechwan
Chengting(2)	3101-3112	WWG	Hopeh	Fowling	2901-2912	SZR	Szechwan
Kiaoho	2901-2912	WWG	Hopeh	Jenshow		SZR	Szechwan
Nankung	3001-3012	WWG	Hopeh	Kaikiang		SZR	Szechwan
Sushui	3001-3012	WWG	Hopeh	Lifan(1)		SZR	Szechwan
Ting		WWG	Hopeh	Lifan(2)		SZR	Szechwan
Tsang	2901-2912	WWG	Hopeh	Lu		SZR	Szechwan
Tsing	2901-2912	WWG	Hopeh	Mienyang	3001-3012	SZR	Szechwan
Tung	3001-3012	WWG	Hopeh	Neikiang	3107-3206	SZR	Szechwan
Kwanyun	3210-3309	WWG	Kiangsu	Pi		SZR	Szechwan
Liaochung	3001-3012	WWG	Liaoning	Shwangliu		SZR	Szechwan

Locality	Time Span	Agr. Area	Province	Locality	Time Span	Agr. Area	Province
Ankiu	2901-2912	WWG	Shantung	Sinfan		SZR	Szechwan
Chu		WWG	Shantung	Sintu		SZR	Szechwan
En(2)	3010-3109	WWG	Shantung	Suining	2901-2912	SZR	Szechwan
Fushan	3011-3110	WWG	Shantung	Ta	3101-3112	SZR	Szechwan
Hweimin	3101-3112	WWG	Shantung	Wenkiang		SZR	Szechwan
Ishui	3001-3102	WWG	Shantung	Futsing		DCR	Fukien
Jihchao		WWG	Shantung	Hweian	3001-3012	DCR	Fukien
Laiyang	3101-3112	WWG	Shantung	Lungki	3002-3102	DCR	Fukien
Lini		WWG	Shantung	Putien	3107-3207	DCR	Fukien
Lintsing(1)		WWG	Shantung	Jung	3201-3212	DCR	Kwangsi
Lintsing(2)		WWG	Shantung	Kweilin		DCR	Kwangsi
Lintze		WWG	Shantung	Liucheng		DCR	Kwangsi
Ningyang	3001-3102	WWG	Shantung	Yungning	3201-3212	DCR	Kwangsi
Pingyuan		WWG	Shantung	Kan		DCR	Kiangsi
Showkwang	3001-3012	WWG	Shantung	Kanchow		DCR	Kiangsi
Taian	3001-3102	WWG	Shantung	Tayu		DCR	Kiangsi
Tancheng		WWG	Shantung	Chaoan	3002-3102	DCR	Kwangtung
Tangyi(1)	3011-3110	WWG	Shantung	Chungshan	3201-3212	DCR	Kwangtung
Tangyi(2)	3011-3110	WWG	Shantung	Fa		DCR	Kwangtung
Teh(1)		WWG	Shantung	Fungshan		DCR	Kwangtung
Teh(2)		WWG	Shantung	Fungshun		DCR	Kwangtung
Tsimo	3202-3302	WWG	Shantung	Hingning		DCR	Kwangtung
Tsining	2911-3010	WWG	Shantung	Hoihong		DCR	Kwangtung
Wei	3001-3012	WWG	Shantung	Hoiping		DCR	Kwangtung
Yi	2901-2912	WWG	Shantung	Kityang	3002-3102	DCR	Kwangtung
Yucheng		WWG	Shantung	Koyiu	3201-3212	DCR	Kwangtung
Fengyang	3206-3305	YRW	Anhwei	Kukong	3201-3301	DCR	Kwangtung
Ho (1)	3001-3012	YRW	Anhwei	Limkong		DCR	Kwangtung
Ho (2)	3201-3212	YRW	Anhwei	Lin		DCR	Kwangtung
Hofei	3101-3112	YRW	Anhwei	Loting		DCR	Kwangtung
Hwokiu		YRW	Anhwei	Mowming	3201-3212	DCR	Kwangtung
Laian		YRW	Anhwei	Mei		DCR	Kwangtung
Liuan	3201-3212	YRW	Anhwei	Namyung(1)	3201-3212	DCR	Kwangtung
Taihu	2901-2912	YRW	Anhwei	Namyung(2)	3201-3212	DCR	Kwangtung
Tingyuan		YRW	Anhwei	Namyung(3)	3201-3212	DCR	Kwangtung

Locality	Time Span	Agr. Area	Province	Locality	Time Span	Agr. Area	Province
Tungcheng	2901-2912	YRW	Anhwei	Suihai		DCR	Kwangtung
Wuhu	3205-3305	YRW	Anhwei	Sunwui		DCR	Kwangtung
Hang		YRW	Chekiang	Taishan		DCR	Kwangtung
Kashing	2901-2912	YRW	Chekiang	Takhing		DCR	Kwangtung
Shaohing(2)		YRW	Chekiang	Tinpak		DCR	Kwangtung
Tehtsing	2902-3001	YRW	Chekiang	Tsengshing		DCR	Kwangtung
Yuyao	3010-3110	YRW	Chekiang	Tsiaoling		DCR	Kwangtung
Shangcheng		YRW	Honan	Tzekam		DCR	Kwangtung
Sinyang	3201-3212	YRW	Honan	Waiyeung		DCR	Kwangtung
Anlu(1)		YRW	Hupeh	Watnam		DCR	Kwangtung
Anlu(2)		YRW	Hupeh	Yanping		DCR	Kwangtung
Anlu(3)		YRW	Hupeh	Yeungkong		DCR	Kwangtung
Anlu(4)		YRW	Hupeh	Anshun(1)	3201-3212	SWR	Kweichow
Chungsiang	2901-2912	YRW	Hupeh	Anshun(2)	3201-3212	SWR	Kweichow
Hanchwan		YRW	Hupeh	Anshun(3)	3201-3212	SWR	Kweichow
Hwangpei		YRW	Hupeh	Kweiyang		SWR	Kweichow
Kishui	3001-3012	YRW	Hupeh	Pan(1)	3201-3212	SWR	Kweichow
Siaokan(1)		YRW	Hupeh	Pan(2)	3201-3212	SWR	Kweichow
Siaokan(2)		YRW	Hupeh	Pan(3)	3201-3212	SWR	Kweichow
Tsaoyang(1)	3111-3210	YRW	Hupeh	Tingfan	3201-3212	SWR	Kweichow
Tsaoyang(2)	3111-3210	YRW	Hupeh	Tsunyi(1)	3201-3212	SWR	Kweichow
Wuchang		YRW	Hupeh	Tsunyi(2)	3201-3212	SWR	Kweichow
Yingcheng(1)	3102-3202	YRW	Hupeh	Tsunyi(3)	3201-3212	SWR	Kweichow
Yingcheng(2)	3102-3202	YRW	Hupeh	Tuhshan	3201-3212	SWR	Kweichow
Yingcheng(3)	3102-3202	YRW	Hupeh	Iliang(1)	3201-3212	SWR	Yunnan
Yunmeng(1)	3110-3209	YRW	Hupeh	Iliang(2)	3201-3212	SWR	Yunnan
Yunmeng(2)	3110-3209	YRW	Hupeh	Iliang(3)	3201-3212	SWR	Yunnan
Yunmeng(3)	3110-3209	YRW	Hupeh	Kunming(1)		SWR	Yunnan
Yunmeng(4)	3110-3209	YRW	Hupeh	Kunming(2)		SWR	Yunnan
Pengtseh	3206-3305	YRW	Kiangsi	Kunming(3)		SWR	Yunnan
Changshu	2901-2912	YRW	Kiangsu	Kunming(4)		SWR	Yunnan
Chinkiang		YRW	Kiangsu	Mengtsz(1)	3201-3212	SWR	Yunnan
Fowning	2901-2912	YRW	Kiangsu	Mengtsz(2)	3201-3212	SWR	Yunnan
Hinghwa		YRW	Kiangsu	Mengtsz(3)	3201-3212	SWR	Yunnan
Hwaian(1)		YRW	Kiangsu	Pinchwan(1)	3201-3212	SWR	Yunnan

Locality	Time Span	Agr. Area	Province	Locality	Time Span	Agr. Area	Province
Hwaian(2)		YRW	Kiangsu	Pinchwan(2)	3201-3212	SWR	Yunnan
Hwaiyin	3210-3309	YRW	Kiangsu	Tali		SWR	Yunnan
Kiangtu(2)	2901-2912	YRW	Kiangsu	Tsuyung(1)	3201-3212	SWR	Yunnan
Kiangyin		YRW	Kiangsu	Tsuyung(2)	3201-3212	SWR	Yunnan
Kunshan	3001-3012	YRW	Kiangsu	Tsuyung(3)	3201-3212	SWR	Yunnan
Tai	2912-3012	YRW	Kiangsu	Yuankiang	3201-3212	SWR	Yunnan
Tanyang		YRW	Kiangsu	Yuki(1)	3201-3212	SWR	Yunnan
Wu		YRW	Kiangsu	Yuki(2)	3201-3212	SWR	Yunnan
Wukiang		YRW	Kiangsu	Yuki(3)	3201-3212	SWR	Yunnan
Wusih(2)	3106-3205	YRW	Kiangsu	Yungien	3201-3212	SWR	Yunnan

Part II: Assignment Allocation Chart

Page Range	Person in Charge
19-36, 82-100	Yuting CHEN
37-81	Mark LAPOINTE
101-137, 359-366	Trevor J. OSGOOD
138-163, 302-318	Wen CAI
164-187	Yuqing ZHANG
188-230	Yu FANG
231-268	Yuan XIA
319-358	Yujiao ZHANG
367-409	Michael D. CHAN
410-444	Huiwen Lu

The digitized process of Buck's statistical volume of *Land Utilization in China* was completed by the undergraduate students (listed above) in Cornell University who took research class for credits. The study group was assembled by Nanhai Zhong (used to be an undergraduate student in Cornell University) and led by Dizi Chang (author of the thesis) under the guidance of Professor Calum G. Turvey for building a database of *Land Utilization in China*— Statistics.